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A SYSTEMATIC EXAMINATION OF GIBBERISH IN A MULTILINGUAL SCHIZOPHRENIC PATIENT*

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An investigation of gibberish in an Indian hebephrenic is reported. The patient's case-history is recounted and the several languages that he spoke are noted. The problems presented by his gibberish are listed. The procedure for recording and transcribing it is presented. Accounts are given of the method of classifying his verbal production and of investigations into the factors evoking the gibberish, its phonetic structure, and its sources. The desirability of further investigations along the same lines is urged.

Discussions about the language of schizophrenics still tend to be based on impression and speculation. The great need in this field at present seems to be the accumulation of more factual material. The case described here was investigated as a contribution to that end. Its special interest lies in the circumstance that the patient uttered a profuse amount of gibberish, while at the same time he was able to speak three languages fluently and had a smattering of two others.

CASE REPORT

B., the patient, was a native of India aged 30 and diagnosed as a case of chronic hebephrenia. He was the son of a medical practitioner and had been a professional officer in the Indian Navy, sent to England for specialist training. His psychosis had had a fulminating onset when he was aged 24. Prior to then he had always been adequately adjusted. He had been successful in study, games, and his career. At all times he had been sociable and popular. There was a family history of mild

instability on the mother's side. Immediately before his psychotic breakdown he had been confronted with a series of stresses ; he failed an important examination ; he was refused entry into a branch of the navy that he ardently desired to join and was directed into another branch ; he was compelled by pressure from his family to break off a developing love-affair with a Norwegian girl ; he was buried under an avalanche when on winter sports in Austria and, after being rescued, he was seriously ill for some weeks with pneumonia ; his father had a severe attack of coronary thrombosis. During the six years of his psychosis he had had a succession of treatments comprising deep insulin, three courses of electroshock, and two courses of resocialization therapy but though he had had remissions in response to these he had invariably relapsed.

The principal symptoms noted in regard to B. were hallucinations, thought disorder, mannerisms, social withdrawal, and deterioration of habits. Beyond one or two references to a word-salad no observations on language disturbance were recorded by any of the neuropsychiatrists who examined him or cared for him. Gibberish was suspected but the situation was obscured by the possibility that what was apparently a flood of neologisms was in fact an unknown Indian language. Data on the development of his gibberish therefore are not available. The interest of clinical psychologists in his speech was roused when he figured as a subject in experiments with disorganized patients. It was then decided to make a systematic inquiry into his verbal production, which was feasible because on the staff of the hospital there was a Pakistani neuro-psychiatrist (S.J.S.) able to cope with the question of Indian languages.

INVESTIGATION

Patient's Linguistic Knowledge

The first necessity was to establish what languages B. actually spoke. This was attained partly by questioning him, since he replied rationally at times, and partly by securing information from his relatives in India. His mother-tongue was *Gujarati*, an Indo-European language of the Indo-Iranic branch, spoken by over 16 million persons, including those of the Parsi religion to which B. belonged. He spoke, read and wrote two other languages with complete fluency and correctness: *Hindi*, the national language of India, and *English*. His pronunciation of the latter had Indian characteristics. He had studied these languages at school. His family spoke, read, and wrote both freely. He had grown up in a household that was virtually trilingual. Hindi was the chief tongue of the region in which his childhood and adolescence were spent. Though Hindi and Gujarati are closely related, they are not mutually intelligible. His specialist reading had been entirely in English. His residence in England had brought it about that English was the language in which he most readily expressed himself. It had become his basic instrument of thought. During his love-affair with the Norwegian girl he had acquired a number of *Norwegian* words and phrases. He did not study the language formally and his knowledge of it had been insecure. When convalescent from pneumonia in Austria he picked up two or three dozen *German* words and phrases.

Problems of the Gibberish

Further inquiry demanded that samples of B's speech should be recorded under standard conditions. Several distinct questions were evident which only the analysis of such samples could answer. Certain possibilities had to be excluded. The presumed gibberish was definitely neither English, German, nor Hindi. It seemed unlikely that it was either Gujarati or Norwegian. Could this be verified ? That done, was it a *pure gibberish*, mere collocations of sounds, or a *private language*, in which neologisms denoted objects, situations, and experiences ? In addition to presumed gibberish B's speech contained rational English expressions, English expressions showing thought disorder, and obvious modifications of English words. How could these expressions most appropriately be classified ? What were their relative frequencies ? How stable were these frequencies in the same situation on different occasions ? The proportions of rational speech and gibberish appeared to vary in different situations. Could any regularities be established in this matter ? According to all investigators (Chrisman, 1896, Hirshberg, 1913, Jespersen, 1922, Priebsch & Collinson, 1934, Partridge, 1935), gibberish and private languages in children and secret languages in adults closely resemble in phonetic structure the natural languages of the speakers. How close was B's gibberish in phonetic structure to the various languages that he knew ? How stable was the phonetic structure of his gibberish on different occasions ? Some of B's neologisms, while not actually German, resembled German words. Others seemed to be modelled on English obscene words. How important were these and other sources ? Could anything be discovered as to the basic sources of the gibberish ?

Sampling of the Gibberish

Tape recordings were made of B's entire verbal production in response to a series of tests and tasks administered under different conditions on three different occasions. The series comprised: (1) Wechsler-Bellevue Form I Comprehension, Similarities, and Vocabulary ; (2) the word-fluency task of naming as many possible colours, animals, birds, trees, flowers, trades and occupations, tools, countries, towns, kinds of food, articles of clothing, parts of the body, boys' names, girls' names, and family names ; (3) describing everything seen in 12 coloured photographs employed by Robertson (1954) in a research on perceptual disorders ; and (4) stating what 24 simple inkblots looked like.

In English the series was administered according to the order listed and readministered in reversed order after a lapse of six months. Instructions and questions were also translated into Urdu and administered one month after the first English session in the same order. Urdu, the national language of Pakistan, is essentially the same tongue as Hindi, differing only in its script and in retaining words of Persian and Arabic origin for which Indic equivalents have been substituted in Hindi. Speakers of Urdu and Hindi have full mutual comprehension.

B. co-operated fully at each session. His verbal production was sufficiently copious. After the first two sessions steps were taken to deal with the problem of excluding

Gujarati and Norwegian. Help was sought from the principal teachers of those languages in the University of London. The Gujarati scholar could find no trace of the language in the recorded replies of the Urdu session. Similarly the Norwegian scholar could find no trace of that language in the recorded replies of the first English session with one doubtful exception. It could be assumed that the apparent neologisms were what they seemed and not words from a natural language.

Transcription of the Gibberish

The replies in the English sessions were composed partly of English and partly of gibberish. Those in the Urdu session were partly Hindi, partly English, and partly gibberish. The English was transcribed in standard spelling, the Hindi according to the usual transliteration. The gibberish, after various approximations, was finally transcribed into International Phonetic Association symbols. The English recordings were transcribed independently by two listeners. Where they were at variance the recording was played over until an agreed transcription was arrived at. The Urdu session was transcribed by one listener.

In this context the difficult problem of deciding what constitutes a word, see Osgood (1953), was met by defining it arbitrarily as the succession of sounds bounded before and after by a known word or a pause. In each English session 136 gibberish words were produced; in the Urdu session there were 119. Not one of these was common to all three sessions. The two English sessions had six gibberish words in common, the first English session and the Urdu session had three, the second English session and the Urdu two. It was considered that the number of words in common would have been much higher if the neologisms were a private language and not a pure gibberish. To determine this question more definitely, however, a list of 15 words was constructed which sampled those common to sessions and those which occurred more than once in the same session. B. was asked on three separate occasions at intervals of one week to say what these words meant. His definitions, which were themselves partly gibberish, were completely different on each occasion. This was taken as conclusive that the neologisms were not a private language.

Classification of Verbal Production

All the expressions in B's replies could be classified systematically as: (1) major appropriate, (2) minor appropriate, (3) neutral, (4) actual inappropriate, (5) composed, (6) modified, and (7) gibberish. *Major appropriate* denoted actual English or Hindi words essential to the meaning of a response and used reasonably in it. They were ordinarily nouns, adjectives, or verbs. *Minor appropriate* denoted actual English or Hindi words not essential to the meaning of a response but merely filling it out and, in so far as they themselves were concerned, used reasonably in it. They were ordinarily pronouns, auxiliary verbs, adverbs, prepositions, conjunctions, or articles, but might include unimportant nouns. They might be combined in the response with major appropriate, actual inappropriate, or gibberish words. *Neutral* denoted exclamations and noises of various sorts. *Actual inappropriate* meant real English or

Hindi words which owing to some form of thought disturbance were unreasonable in the response. *Composed* denoted real English or Hindi words combined into a meaningless compound, e.g. "cottonpoint", "ricetank". *Modified* meant real words with a slight phonetic change or addition of a sound, e.g. "distributen" for "distribute". They might be used appropriately or inappropriately. *Gibberish* meant collocations of sounds not identifiable as words in any of the languages with which B. was acquainted.

In the first English session the percentages of these classes were: 9·2, 37·4, 8·3, 21·2, 3·0, 1·4, and 19·5. In the second English session they were: 9·3, 40·4, 6·8, 21·4, 3·5, 1·0, and 17·6. In the Urdu session they were: 12·5, 33·2, 1·7, 22·2, 0·3, 2·0, and 28·0. The two English sessions show a very close correspondence. The Urdu session has a higher proportion of gibberish but does not differ to a statistically significant extent. It can be said therefore that in the same general kind of situation on different occasions the structure of B's speech and the proportion of gibberish in it remained quite stable. It is noteworthy that in the Urdu session actual inappropriate, composed, and modified words occurred much more in the English than the Hindi parts of the replies. Within supporting words of either language gibberish tended to function as the equivalent of a major appropriate word, usually a noun, less often a verb or predicative adjective.

Factors evoking Gibberish

The proportion of gibberish varied considerably in different parts of the recordings. This was also true of the proportion of other inappropriate words. Five possible evoking factors were considered here: increasing fatigue ; increasing familiarization with the examiner ; changes in the difficulty of questions and tasks ; the nature of questions and tasks ; and the residual factor of uncontrolled stimulation internal to the patient.

If either fatigue or familiarization were responsible the proportion of gibberish would be expected to rise steadily in each session. This was true in the first English session. It was not true in the second English session where the proportion steadily fell nor in the Urdu session where it rose and then fell. If more gibberish were produced when items became harder it would be expected that in the tests with questions arranged in order of difficulty (Comprehension, Similarities, Vocabulary) the proportion of gibberish would be low at the beginning and rise steadily through the test. On the contrary it would be expected that in tasks with items of approximately uniform difficulty (word-fluency, picture description, blot description) the proportion of gibberish would remain constant throughout. Neither of these expectations was verified in any of the three sessions. Fatigue, familiarization, and difficulty of task could be rejected as important evoking factors. That the nature of the task was the important factor seemed clearly indicated by the English sessions. Here in both orders the proportion was low in Comprehension and Similarities ; it was fairly high in Vocabulary, word-fluency, and picture description ; and rose to a peak in blot

description. This might be interpreted by saying that where the task was precise and delimited the proportion of gibberish was low ; the vaguer and less bounded it became the greater was the proportion of gibberish. This interpretation, however, was only partially confirmed by the facts of the Urdu session, where the proportion of gibberish was at a peak in Vocabulary and very low in the description tasks. The influence of kind of task appeared therefore to be complicated by factors purely internal to B. All the statements just made about the gibberish also applied to the other inappropriate words.

Phonetic Structure of the Gibberish

Frequency distributions were tallied for each sound (29 consonants and 14 vowels or diphthongs) transcribed from the gibberish in the recordings of the three sessions. Separate distributions were tallied for the initial, medial, and final positions in a word. These frequencies were converted into proportions of the total number of sounds in that position. Product-moment correlations were then calculated between the sessions for the proportions in each position. The correlations between the two English sessions were 0·95, 0·99, and 0·97. Those between the English sessions and the Urdu ranged from 0·89 to 0·97. It may be said therefore that the gibberish showed a high degree of phonetic stability from one occasion to another.

For purposes of comparison similar frequency distributions and proportions were tallied for transcriptions into International Phonetic Association script of samples from the five languages involved. For the initial and medial positions these samples were drawn from word-lists ; for the final position they were taken from continuous passages. The English sample was transcribed in accordance with B's Indian-type pronunciation. Gujarati, Hindi, and Norwegian material was taken from standard works offering full information on phonology and with transcribed material in them. The works employed were: Taylor (1908) for Gujarati ; Bailey, Firth & Harley (1950) for Hindi ; and Marm & Sommerfelt (1943) for Norwegian. Correlations were calculated between the proportions in the various languages for the three positions and the corresponding proportions in the frequencies of the English sessions and the Urdu session.

The general findings may be easily stated. The closest resemblance of the gibberish in both the English and the Urdu sessions was to the phonetic structure of English. The next closest resemblance was to Hindi but this was rather more marked in the Urdu session. The third closest resemblance was to Norwegian. This relationship was probably heightened by the similarity in phonetic structure between Norwegian and English. Where there was a statistically significant difference in frequency between English and Norwegian the gibberish was more than two-thirds of the time closer to the English proportion. The gibberish was most distant phonetically from German and Gujarati, least like German in the Urdu session and least like Gujarati in the English sessions.

One or two points of detail should be added. In all sessions there was a strikingly

close resemblance to Gujarati in the proportions of medial vowels. In the first English session and only there a strikingly close resemblance to German frequencies was found in two respects: a large proportion of words began in a sibilant plus a consonant and a large proportion of words ended in the nasal *n*. These German-type forms appeared to be largely variations on the word *sprechen*.

It is realized that subjective determinants in the listeners may have rather distorted the phonetic facts of the gibberish, especially as the basic concept of the phoneme was impossible to apply meaningfully in this context (see Osgood, 1953 and Osgood & Sebeok, 1954), but the main trends seem to be quite definite. The phonological structure of B's gibberish was essentially English with general influences also present from his two Indian languages and a specific influence present from German.

Sources of the Gibberish

The phonetic evidence confirmed that German words learnt in Austria six years before could still operate as a source of the gibberish. Other sources in the past could not be assessed. Obscene elements might for instance have some special relation to the stresses operating on B. at the time of his breakdown but they might equally well derive from his immediate environment. It seemed profitable to investigate here the extent to which words presented in his immediate situation were incorporated as elements in the neologisms. Two sessions were arranged for this purpose. In each B. was asked to describe some pictures and his gibberish was noted. He was then handed a series of 20 cards displaying Spanish or uncommon English words and asked to state what they meant. He was afterwards asked to describe the pictures again and his gibberish noted. The pictures and the displayed words were different on the two occasions. In one session two and in the other three of the displayed words were included as elements in the subsequent neologisms. It could be inferred that words in B's immediate environment were quite likely to be incorporated as sources of his gibberish.

Attempts to discuss with B. the nature of his gibberish were quite unsuccessful. He was prepared to utter unlimited amounts of it, as it were in playful mood, but not to tolerate a direct inquiry into it nor to work elements into it on the explicit instructions of the examiner.

DISCUSSION

This investigation leaves a number of questions unsettled.

It would be desirable to conduct further experiments on the relation of measures of linguistic dominance to the phonetic structure of the gibberish and to explore more fully the effects of situational and contextual factors. For the time being this is precluded because the patient has passed into another remission in which he is more self-critical and also much less co-operative. His production of gibberish has temporarily shown a substantial reduction.

It is not clear how far the circumstance that B. was multilingual was relevant to the fact that his thought disorder especially took the form of speaking gibberish. It is also not clear whether his gibberish is to be regarded as a reversion to a linguistic stage of childhood. According to Chrisman (1896) and Jesperson (1922) gibberish and afterwards secret languages are common linguistic phenomena in late childhood found in all races and cultures, but it is a well-exposed error to equate the behaviour of disordered adults with that of children in the absence of definite evidence. These and similar questions can only be settled with the aid of developmental data and by the study of a number of cases. The foregoing investigation demonstrates that marked regularities may be found in the most disorganized speech of schizophrenics These regularities exist in the proportions of rational and disturbed language, in the situations that evoke the disturbed language, in its phonetic structure, and in its sources. The investigation points to the desirability of wider studies along the same lines.

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HISTORICAL, DESCRIPTIVE AND DYNAMIC LINGUISTICS

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The neo-grammarian school (1870-1900) established a conception of linguistics as a science based on detailed observation of language and accurate formulation of observed processes. This has led to a shift of attention from historical studies to the investigation of living language, which is better able to meet the requirements of this conception. The validity of traditional historical methods of reconstruction and explanation has appeared increasingly suspect. The insight of descriptive structural linguistics may help to refine the formulation of historical systems and processes, but cannot establish their validity, nor provide more than a most restricted dynamic of language change. This must spring from the establishment of the dimensions of variation within a language community, the conditions of usage and balance of apparently competing forms (linguistic ecology), and the observation of the action of selection pressures upon their distribution.

We now face the great generation of neo-grammarians across a temporal gap of 50-80 years—as long, that is, as the period that separated them from the beginnings of systematic comparative grammar. One may perhaps now attempt to put their achievements into perspective, and try to evaluate subsequent developments.

The great and permanent achievements of the generation of 1870 can be summarised as having provided us with the conception of linguistics as an exact science, possessing a rigorous discipline, an explicit methodology, insistence upon an exact, detailed observation of facts, a determination to penetrate to the reality behind the symbols of a written text and the abstractions of descriptive grammar. These gains are now so completely consolidated that it is difficult for us to recapture the excitement of showing, for the first time, that an aspect of human behaviour was amenable to scientific investigation, that it was regular, coherent, and subject to causal laws, and that an elegantly small number of simple, explicit principles " einfache Grundgedanken mit strenger Konsequenz durchgeführt " (Paul, 1920) could reduce to one integrated structure a mountain of material drawn from a large number of languages over a period of many centuries.

These principles were not completely novel ; the ground had been long prepared. A basis for the systematic comparative study of languages was being laid well back

in the 18th century before the critical introduction of Sanskrit to the west (Gatterer 1771, Adelung, 1781), whilst the primacy of detailed observation over facile generalization was emphasized by Grimm (1822). Their full application was hampered, however by several factors. First, of course, the very weight of material awaiting treatment made it inevitable that easy correlations should be drawn, and problems shelved. This tendency was however reinforced by a disbelief in the regularity and consistency of human behaviour. This was largely a revolt against 18th century rational and philosophical grammar and *Aufklärung* in general, but may have roots further back in the Babel legend of the arbitrary confusion of tongues by a capricious deity, which had suited so well the temper of the 17th century. The second factor was the obsession of the earlier comparatists with the *Ursprache*. This was partly an aspect of Romantic retrospection to the age of gold, which saw in Indo-European a primordial language of regularity and beauty before our latter-day decline and decay. Working on a more restricted scale of time and space than we can now contemplate, Indo-European appeared very close to the fount of things.

As the golden dream faded, the retrospective view seemed ridiculous and yielded to the progressive view. Henry Sweet, addressing the Philological Society in 1876, expressed this most strongly: — " One of the most striking features of the history of linguistic science as compared with zoology, botany and the other so-called natural sciences, is its one-sidedly historical character. Philologists have hitherto chiefly confined their attention to the most ancient dead languages, valuing modern languages only in as far as they retain remnants of older linguistic formations. Much as if zoology were to identify itself with paleontology and refuse to trouble itself with the investigation of living species except when it promised to throw light on the structure of extinct ones.

" Philologists forget, however, that the history of language is not one of decay alone, but also of reconstruction and regeneration. These processes are of equal, often more importance than those by which the older languages were formed and besides often throw light upon them. They have further the great advantage of being perfectly accessible to the observer. Thus the growth of a language like English can be observed in a series of literary documents extending from the 9th century to the present day, affording examples of almost every linguistic formation

" But before history must come a knowledge of what exists. We must learn to observe things as they are, without regard to their origin, just as a zoologist must learn to describe accurately a horse, or any other animal. Nor would the mere statement that the modern horse is a descendant of a three-toed marsh quadruped be accepted as an exhaustive description. Still less would the zoologist be allowed to ignore the existing varieties of the Equidae as being ' inorganic ' modifications of the original type. Such however is the course being pursued by most antiquarian philologists. When a modern language discards the cumbrous and ambiguous inflexions it has received from an earlier period and substitutes regular and precise inflexions and agglutinations of its own, these formations are contemptuously dis-

missed by the philologist who forgets that change, decay and reconstruction are the very life of language—language is 'inorganic' only when it stands still in its development.

"The first requisite is a knowledge of phonetics, or the form of a language. We must learn to regard language solely as consisting of groups of sounds, independently of the written symbols, which are always associated with all kinds of disturbing associations, chiefly historical. We must then consider language in its relation to thought, which necessitates some study of the relations of language to logic and psychology. Such investigations if carried out consistently, will greatly modify our views, not only of English, but of language generally, and will bring us face to face with many of the ultimate problems of language which have been hitherto shirked by philologists" (Sweet, 1876).

This passage is, I believe, of the greatest wisdom and importance. In its light we can follow the immediate flowering of historical linguistics and its subsequent decline.

First as to the flowering. The way was now open for the consistent application of scientific principles, based upon the primacy of spoken language, with the development of phonetics in the sense of Sievers' *Lautphysiologie* (1901), as the basic tool for its analysis. It was at the phonetic level of language that the regularity and universality of change—"dass Gleiches unter gleichen Bedingungen gleich behandelt wird" (Brugmann, 1901)—could be most convincingly demonstrated.

In the words of Wundt: "Darin besteht, wie mir scheint, das Wesentliche und zugleich das unleugbare Bedeutsame der in der neueren Sprachwissenschaft zur geltung gelangten Anschauungen, dass die Ausnahme nicht als eine nicht weiter zu untersuchende Thatsache zugelassen wird, sondern dass man sich die Aufgabe stellt, die intercurrierenden Ursachen nachzuweisen, welche die Ausnahme erklären."

In the last quarter of the 19th century the principles explicitly stated in the *Prinzipien der Sprachgeschichte* were applied to the whole range of Indo-European languages and proved capable of application to other languages. A series of standard works appeared, which are still reprinted, with some re-editing. Braune's Althochdeutsche Grammatik reached its eighth edition in 1953 (Ed. Mitzke) and Paul's Mittelhochdeutsche Grammatik its sixteenth (Ed. Schmitt) in the same year. The phonology or *Lautlehre* of these works is familiar to us all. First a list of letter symbols is given, and the sounds to which they correspond are phonetically defined. The relation of these to those found in corresponding words first in the preceding, then in the succeeding stage of the language is stated ; here a general law is posited, modified if need be by listing deviate developments and ascribing these to the influence of aspects of the phonetic environment or to the workings of analogy.

A further section on *Lautwechsel* explains divergent forms of cognate words by referring them to the regular action of phonetic laws at some earlier period (*Ablaut, Umlaut*, Verner's law, etc.).

In the first decade of this century, few, if any, would have been found to deny the proposition vigorously propounded by Hermann Paul (1920): "Sprachwissenschaft ist gleich Sprachgeschichte". "Es ist eingewendet", he wrote, "dass es noch eine

andere wissenschaftliche Betrachtung der Sprache gäbe, als die geschichtliche. Ich muss das in Abrede stellen ! "

This outlook has left the strongest possible imprint on the structure of modern language departments in universities, which commonly have a " literary " side and a " linguistic " side, the latter dealing exclusively with historical problems. Varying degrees of skill in manipulating the contemporary language are required for translation and composition, but it is not subjected to any systematized analytical treatment. This structure is still substantially intact, but the philosophy which supports it has progressively weakened over the last half-century.

By 1949, George S. Lane, writing in " Language ", felt obliged to introduce his review of the " Present State of Indo-European Linguistics " with the following words :— " For more than a generation now the bulk of scientific linguistic publication in America has been devoted to descriptive linguistics and the vast majority of the last generation of students of linguistics have devoted themselves largely to that field. The larger measure of scientific advance has accompanied the larger measure of devotion. That is to be expected. There have, of course, been notable exceptions. But I believe the facts will bear me out in my observation that these notable exceptions have been due to the continued labours of an older generation of scholars.

" And likewise abroad, again with notable exceptions, the 19th-century brand of linguistic science has in recent years been neglected by the younger scholars in favour of the pursuit of other aspects of language study.

" These observations being true, the Indo-Europeanists trained in their discipline in more recent years are given cause to hesitate a moment and ponder on the present status of their science and consider the possibilities of its further development. Is comparative Indo-European grammar a closed chapter of linguistic research ? Is a younger scholar dealing with an old problem of Indo-European phonology an anachronism, ' a voice from the nineties ', as I heard it put once on such an occasion ? Should we discourage our students from entering upon the controversies of fifty or seventy-five years ago in favour of their taking up the newer, richer, and more quickly remunerative branches of language study which have been the centre of attention for over a generation now ? These are questions to be seriously considered by graduate teachers."

These questions present a challenge which the events of the past ten years have sharpened rather than diminished. In trying to arrive at an answer, one has to account for a radical change of climate. The Oslo Congress (1957) revealed structural descriptive linguists as a self-confident, even complacent, establishment. Nor could it in any way be said that the challenge to historical linguistics is less than to comparative studies. Rather the reverse. For comparative studies are, as it were, open. The past extends as indefinitely as the future. There is room for many hypotheses, and above all there has been the invigorating impact of the periodic discovery of fresh ancient languages as a result of archaeological explorations, with consequent challenges first to decipherment, then to confirmation of some hypotheses, to fresh problems and the reconsideration of the total structure of interdating in their light. It is the injection

of new material which has prevented comparative Indo-European linguistics from stultifying and maintained the feeling of a living science.

In the case of the historical study of particular languages, on the other hand, there has not been, nor is there likely to be, a significant access of fresh material, except at the near end, of course, as the present becomes the past. Over the greater period of time one is dealing with a virtually closed corpus of texts. This in itself goes far to account for a subsequent quiescence in historical linguistics, particularly in phonology. The great generation codified sound changes in the historical period so thoroughly that subsequent workers were faced with a diminishing number of problems, intractable in character and often marginal in importance. There is little excitement involved in the mere preservation and transmission of a body of received knowledge. When this stage is reached, one can expect that a period will be made, and a new paragraph begun. Research takes a new direction, and it is not long before this time is held by many to be the beginning of scientific thought. In this view, any decline in historical linguistics would seem only relative. Those who continue to work in this tradition could claim that their progress, though less dramatic than that of the neo-descriptivists who have been fashioning a new science, has been steady and real.

II

I would suggest, however, that it is not adequate as a complete explanation. The classical *Lautlehre* is not perfect and will not in fact stand up to critical examination in the light of our present knowledge. However systematic and coherent its picture, it rested upon no secure basis. The nature of linguistic processes was not understood, and as a result the language used was unwittingly metaphorical and the processes described but pseudo-processes. There is indeed good evidence to show that the major late nineteenth-century linguists were aware of growing doubts as to the nature and validity of their underlying assumptions. In particular, two questions arose: how far can one penetrate to reality, and what is the dynamic of language change? A feeling arose that the time was fast approaching when these must be checked against observations made on living language. I would refer back to Sweet's programme: " Before history must come a knowledge of what exists. We must learn to observe things as they are, without regard to their origins ". The irony lies in the inversion of logical and historical order. Historical studies preceded the study of what is, thanks to Sanskrit and romanticism. Once the prestige of age was gone, insistence on exact observation, on penetration to reality led straight to the investigation of language activity as it occurs now, around us: " perfectly accessible to observation ".

This view is, surprisingly perhaps, strongly supported by Paul (1920). Having defined " den psychischen Organismus " as the corpus of associated sounds and images built up in the mind of a member of a speech community by the practice of speech, and claiming that these are " die eigentlichen Träger der historischen Entwickelung.

Das wirklich gesprochene hat gar keine Entwickelung " he talks of the difficulties of observing it. " Direkt ist er überhaupt nicht zu beobachten. ... Er ist immer nur zu erkennen an seinen Wirkungen, den einzelnen Akten der Sprechtätigkeit ". Basic is a phonetic description of speech. Then: — " Das Ideal einer solchen Darstellungs- weise ist nur da annähernd zu erreichen, wo wir in der Lage sind, Beobachtungen an lebendigen Individuen zu machen." " Wo wir nicht so glücklich sind, ... müssen wir uns bestreben ... aus dem Surrogate der Buchstabenschrift die lebendige Erscheinung ... herzustellen. Dies Bestreben kann aber nur demjenigen glücken, der einigermassen lautphysiologisch geschult ist, der bereits Beobachtungen an lebenden Sprachen gemacht hat, die er auf die toten übertragen kann, der sich ausserdem eine richige Vorstellung über das Verhältnis von Sprache and Schrift gemacht hat ".

Turning to the question of the internal psychic aspect of the speech-act he speaks of the need for self-observation. " Immer von neuem angestellte exacte Selbstbeobach- tung, sorgfältige Analyse des eigenen Sprachgefühls ist ... unentbehrlich für die Schulung des Sprachforschers ". What we observe in ourselves we extend analogically to others and the closer we are to them the better: " An der Muttersprache lässt sich daher das Wesen der Sprechtätigkeit leichter erfassen als an irgend einer anderen. Ferner ist man natürlich viel besser daran wo man Beobachtungen am lebenden Individuum anstellen kann, als wo man auf die zufalligen Reste der Vergangenheit angewiesen ist. Denn nur am lebenden Individuum kann man Resultate gewinnen, die von jedem Verdachte der Fälschung frei sind, nur hier kann man seine Beobach- tungen beliebig vervollständigen and methodische Experimente machen ". This is more forceful and convincing than his defence of the thesis " Sprachwissenschaft ist gleich Sprachgeschichte " with which it cannot easily be reconciled. The case for turning from the past to the present could not be better put, and seems to have imposed itself upon him as a result of a conscientious effort to state his presuppositions.

III

The subsequent development of descriptive linguistics can be seen as being a necessary next step rather than a rejection of the past ; a period of pause in historical studies to allow the logical order to reassert itself. One might expect the next generation to concentrate upon the methods of analysing and describing contemporary speech activity, while simply preserving, without comment, the findings of the neogrammarians. This is in fact so of its two most influential figures, Bloomfield and de Saussure. It is noteworthy that the newer developments all took place outside Germany, which became increasingly isolated.

Bloomfield is in the more direct line of descent from the neo-grammarian tradition, basing himself on observation of actual behaviour, and developing a methodology of analysis and description. In this he learnt much from the phonetics of Daniel Jones. Jones did not come to phonetics from a background of linguistic training, his link with Sweet and Sievers being indirect through the pedagogic tradition of Viëtor and

Passy. He was therefore able to concentrate entirely on the practical observation, description and production of speech sounds. At that juncture this break was a strength, and greatly assisted the discipline to develop into an autonomous, vigorous branch of language study.

In particular, the search for a consistent principle of phonetic transcription, consisting of a text of the greatest simplicity consistent with freedom from ambiguity, backed by a body of explicit, detailed conventions, led to the discovery of the phonemic principle, which has been most fruitful in the development of the structural approach to descriptive linguistics (Jones, 1950, 1958). Jones, a strict phonetician, has not been concerned with other levels of language, but it was natural that the development of a rigorous methodology for the phonemic analysis of languages, irrespective of their genetic adherence, should lead others to the extension of this methodology to the analysis of other levels of language. The development of American linguistics over the last twenty years, while acquiring its own distinctive features, has closely followed this pattern.

The European tradition of structural linguistics has stemmed from the teachings of F. de Saussure. By far the more fruitful section of de Saussure's work has been the " linguistique synchronique " in which he reasserts the claim of a language at a particular time to be treated as a system of values, rather than as a mere assemblage of individual items. The aim of linguistic analysis is to refine from a heterogeneous mass of observed acts of speech the system of signs which makes communication within a speech community possible. These signs are forms, defined by their relations, not positive entities. " Dans la langue il n'y a que des différences sans termes positifs," " la langue est une forme et non une substance ". This applies as strongly at the phonological level as at any other: " il est impossible que le son, élément matériel, appartienne par lui-même à la langue." " Chaque idiome compose ses mots sur la base d'un système d'éléments sonores dont chacun forme une unité nettement délimité et dont le nombre est parfaitement déterminé. Or, ce qui les caractérise, ce n'est pas, comme on pourrait le croire, leur qualité propre et positive, mais simple-ment le fait qu'ils ne se confondent pas entre eux. Les phonèmes sont avant tout des entités oppositives, rélatives et négatives." Since " la linguistique a pour unique et véritable objet la langue envisagée en elle-même et pour elle-même," it is clear that, in this view, our object in analysing the language underlying a particular text will not be to re-establish the sounds produced, but to reconstruct the system of phonemic relations which constitute the phonology of the language.

It is of course immaterial whether the particular *état de langue* under analysis is contemporary or past, these principles apply equally. The revolutionary implications of this doctrine for historical linguistics are clear: historical grammars require com-plete reformulation and revaluation if their statements are to be linguistic, i.e. to reveal *la langue*, the language system, involved.

One might also imagine that there is an implication that the relation between successive *états de langue* as reconstructed from texts of successive periods would have to be handled solely from the point of view of changes in the system, changes,

that is, in the relations of comparable items. De Saussure did not however draw this conclusion. The view of linguistic change, expounded in "*linguistique diachronique*," is fully and explicitly neo-grammarian.

It is clear that de Saussure did not expect his teaching to revolutionize historical linguistics, nor even modify it. What did he expect?

" Après avoir accordé une trop grande place à l'histoire, la linguistique retournera au point de vue statique de la grammaire traditionelle, mais dans un esprit nouveau et avec d'autres procédés, et la méthode historique aura contribué à ce rajeunissement."

This was a reasonable forecast, and has been largely fulfilled. The history of linguistics since 1920 has been predominantly a story of the steady development of the analysis and description of the structure of living languages. In Britain and America this development has been more in the neogrammarian tradition, emphasizing the primary observation of language activity. The techniques of structural analysis and description have been developed to facilitate an ordered, systematized observation and communication between linguists.

The continental schools deriving from de Saussure (with debts also to Bühler and Humboldt) have emphasized the logical primacy of the linguistic system and its liberation from the necessary raw material of observation.

However, the two traditions are, by the nature of speech and language, not diametrically opposed, and with increasing contact in the 30's and since the war their development has been convergent, their differences largely verbal and marginal.

On the phonological level of language, the primary unit is generally accounted the phoneme[1]. A great deal has of course been written over the last 30 years on the phoneme. Most of the discussion is on definition and particular solutions in cases of ambiguity. In fact, the phonemic solution adopted for a particular language by scholars of different schools varies little. The phoneme is generally held to be the smallest unit of linear structure. The phonemes of a given language are established first by establishing commutation sets within " the same " frame. For instance, /pit, tit, kit, bit, fit, sit, hit, rit, lit, mit/ establishes 11 distinctive oppositions in the frame /-it/. A word is segmentable into as many phonemes as it enters into sets of this sort. Thus /pit/ has three, since it enters into the above set and also /pit, pi:t, pet, pæt, pa:t, pɔt, pɔ:t, put, pʌt, peit, paut/, and /pit, pip, pik, pig, pitʃ, piθ, pil, pin/. A very large number of commutation sets result. These are then compared, and their members matched so far as possible on the grounds of general phonetic similarity of a similar distinctive oppositional relation to the other members of their respective sets. Once matched, corresponding members from different sets are grouped into one large classificatory unit, the Phoneme, and are termed allophones of this phoneme, constituting its distribution. The procedure continues until all items

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[1] *For a dissenting view see J. R. Firth, esp. Sounds and Prosodies,* Trans. of the Philological Society 1948. *Firth believes that " systems " can be set up only at particular places in linguistic structures, and that it is incorrect to combine units from different systems into one over-all system.*

in all sets have been allocated to phonemes, keeping the number of phonemes as small as possible and providing them with the widest possible distribution.

This part of phonology is thus stated by enumerating the phonemes, defining them by the criteria according to which allophones were assigned to them, detailing their distribution (i.e. the positions, or sets, in which they can occur) and giving any further particular characteristics of the allophones occurring in those positions.

Phonemes are by definition the shortest units in the linear hierarchy, and the fewest in number. But although they are phonologically indivisible on the linear scale, phonemes are seen to occur in phonetically related sets, e.g., ptk/bdg, and from these a common oppositional feature can be abstracted (fortis/lenis, etc.). Germanic /d/ is lingual (b), apical (g), lenis (t), oral (n), interrupted (z). In this way a phoneme may be regarded as a *simultaneous* bundle of such features, which are far fewer in number and perhaps more basic to linguistic structure. Phonemes are combined linearly to constitute units of increasing magnitude, each of which may be characterised by further phonological features, termed prosodies. These may be accents, which characterize words, or intonations, characterizing groups of words.

The statement of the combinability of units once identified into units of greater magnitude is the province of structural grammar. The techniques employed are not so different from those of structural phonology. The simplicity of the basic concepts involved, and the continuity of processes from the lowest to the highest levels is indeed one of the most attractive features of the method. In all cases the basic idea is to set up frames, and to commute items within these ; and then explore the relations between these items, and their oppositional, differentiating function. This approach is applicable to semantic problems also. The anatomy of language revealed is intricate and beautiful, and this discipline, neglected, even discredited, because of a 19th century reaction to 18th century limitations, must surely return. It is as basic to other kinds of language study as is anatomy to other kinds of zoological study.

IV

Can the application of the methods and insights of structural descriptive linguistics be expected to rejuvenate its historical partner ?

Certainly a re-writing of historical grammar from this point of view is overdue and would be most revealing. Many pseudo-problems would be eradicated. As an example of this one might cite Notker's Anlautsgesetz. The Classical formulation is that the voiced plosives /bdg/ derived from Germanic /ββ ɤ/ became voiceless in contact with voiceless consonants and pause. There is thus an interchange of consonants in the same word in different contexts (unde demo golde/tes koldes) a practice which arouses feelings in most commentators of admiration or amusement. On the other hand, however, /t/ from Germanic /d/, remains invariant (unde demo tage/tes tages). This fact excludes Dieth's (1950) hypothesis that /bdg/ underwent the " regular " UG development to /ptk/ and were then " lenisiert " in voiced surroundings. This would

presuppose an etymological consciousness which can be dismissed.

But if we look at the employment of /ptk, bdg/, we find only one opposition /t-d/, and this occurs only in voiced surroundings. In other positions only one value occurs, represented as /t/. In the case of /pb/, as of /kg/, only one phoneme is involved, represented as /b/ or /g/ in voiced surroundings and /p/ and /k/ in unvoiced. (No Germanic /p/ or /k/ in Upper German then.)

We should be chary of ascribing a particular value to these symbols which rest on no oppositions.

If we look at the position in modern Swiss-German (Dieth, 1950) we find that the opposition fortis/lenis occurs only in voiced surroundings. In absolute initial positions and in contact with voiceless sounds a middle value (halb-fortis) is found. Let us assume this to be true for Notker. He distinguishes /d-t/ in voiced surroundings as fortis-lenis. What is he to do with the halb-fortis ? Alphabetic practice requires him to allocate it either to the t or d phoneme. He chose /t/. This involves the noted morphological interchange of /d/ and /t/, which consistency requires also for the other plosives. It seems that the practice was extended for a while to /f/ and /v/ but given up. Only one phoneme is involved and the influence of /t-d/ too remote. If he had chosen /d/ it would appear that the /t/ from Gmc /d/ became (or remained) voiced in voiced surroundings, while /bdg/ from Gmc /βδɤ/ remained unchanged. Or had Notker written morphologically instead of phonologically (as with the Modern German *Auslautsverschärfung*) no problem would seem to present itself.

Of course, it may not be justifiable to equate Notker's Swiss (in this respect) with Modern Swiss. This shows simply how many solutions are possible once neutralisation occurs.

This is true on a large scale with the phenomenon of Umlaut. If we assume alphabetic writing to be substantially phonemic (in the absence of an orthographic tradition) we may expect that a single symbol covers a more or less wide range of different speech sounds (allophones) conditioned by the phonetic context. This means that the so-called identical frames are not strictly so, and that words are rarely distinguished in fact in one segment only, but by features which spread further. In S. English kik/kuk not only the vowels are different, but also the initial and (to a lesser extent) the final consonant. A palatal feature marks the whole first part of /kik/ as opposed to a labio-velar feature over the whole first part of /kuk/. Phonemic (and alphabetic) procedure requires us to regard the differences in either the consonant or the vowel as distinctive and in the other as conditioned. We could take either, but on grounds of economy we take the vowel ; we need the distinction i/u elsewhere, but not $k+/k-$. The choice here seems obvious, but is by no means always so.

If for example a long quality component extends over more than one syllable the phenomenon of vowel harmony results. We may choose between marking this difference on either first vowel, medial consonant (or cluster) or second vowel. We are likely to proceed on the same basis as before, asking whether a particular distinction is needed elsewhere. We should not normally expect to mark the distinction

at all points (unless in each case we required only to use units needed elsewhere, when one might as well do so as not).

This has some implications for Gmc Umlaut. It is the marking of vowel harmony that requires explanation, not its absence. The " secondary *Umlaut* ", whereby the vowel difference in the first syllable is marked only when that in the second is not, must be regarded as the normal state of affairs. It can be explained purely as a change of localisation of distinctive difference, which may or may not be associated with a phonetic development. It is the " primary " *Umlaut,* the marking of a difference in the first vowel whilst that in the second is still shown, that is odd. An explanation may be sought, I think, not simply in the fact that e was available in the Roman alphabet, but in the fact that " Umlaut "-e is considered to have been closer than " Brechungs "-e. Whether or not one must posit an intermediate coalescence I do not know, but once /a/ + /i/ was closer than /i/ + /a/ it must have seemed obvious enough to group them as one phoneme, their difference dependent on the following vowel in a familiar way. This would leave /i/ and /a/ with defective distributions, /i/ not occurring before /a/ and /a/ before /i/ only in limited contexts. One may then view analogical formations like *gesnitan* as beginning to fill these gaps.

It is clear, however, that an acceptable solution is possible only after a proper phonological analysis of all the older Germanic languages.

Perhaps this accounts to some extent for the absence of a thorough reappraisal of the corpus of historical grammar. If linguists who have acquired in descriptive work a grasp of structural principles, together with a sound phonetic training and appreciation of the relation of language to speech and writing, turn to historical studies, they cannot help but be appalled at the complexity of factors in the problems to be solved, and the extreme indeterminacy and non-uniqueness of solution at the end of it all. Their work results then in suggested solutions for restricted problems, adding to what Meillet (1921) called ; " une poussière d'explications dont chacune est juste peut-être, mais qui ne constituent pas un système, et qui ne sont pas susceptibles d'en constituer jamais un ". These restricted problems may be to reconstitute a given *état de langue* or reformulate fruitfully a given development. But neither type of work, though intellectually rewarding, can really supply a dynamic to linguistics.

V

The underlying reason for what I believe to be a genuine decline in historical linguistics—evidenced in many universities by a strong movement away from " language " to literature—is a general loss of faith in the efficacy of historical explanation. We try to understand our present position by analyzing the component forces now in play, not by tracing *post facto* the long chain of major forces which have brought it about but may have ceased to operate.

Now I should say that this interest in organisation as opposed to genesis is a major feature of our time, finding its reflexes in all intellectual spheres. The social sciences

have replaced political history as the basis of governmental action. Within our own field, the recent developments in linguistics clearly have striking points of resemblance to the recent movement of literary criticism. Criticism used to aim at the integration of texts, in a generalised fashion, into a broad sweep of development, showed the derivation of certain of their features from earlier work, their relation to similar features in other contemporary works and the influence they exercised on subsequent work. Now, however, the individual text is approached as a discrete, autonomous entity, and criticism aims at the analysis of its fine structure and the interrelation of its parts. The application of this method to mediaeval works is a logical step, and represents an advanced stage of this movement.

The neo-grammarians believed passionately in the historical method because it alone explained the forms of language. Do we any longer believe that it does ? The mechanism of sound laws gives evidence only of regularity and coherence of development. It provides no dynamic. This is true less of the classically " conditioned " changes, attributed to some influence of the phonetic environment in which sounds are found, though even here assimilation, elision, etc. provide us with descriptions of restricted " changes " rather than explanations. Their operation is too sporadic for a statement of their occurrence to be self-explanatory.

But it is of course the general, so-called " spontaneous " sound changes which offer the most overt challenge to historical explanation.

Schuchardt saw this. Writing as early as 1886 " Uber die Lautgesetze ", he wrote: —

" Welchen Sinn haben alle die Tausende von Lautgesetzen, solange sie isoliert bleiben, solange sie nicht in höhere Ordnungen aufgelöst werden ? . . . In Einzelnen müssen wir das Allgemeine finden lernen, und danach ist auch die Erkenntnis einer Tatsache, welche das ganze Sprachleben beherrscht, von grösserer Wichtigkeit als die Erkenntnis irgend welcher Erscheinungsform."

Paul developed a theory of " Verschiebung des Bewegungsgefühls ". The kin-aesthetic sense controls articulation. It is not fixed. Habits require reinforcement, and in the course of time are modified—one cannot say in what direction, though it might be related to changes in the position of rest (*Indifferenzlage*) of the tongue. This view, favoured by Sievers, and contributing to the *Schallanalyse* theory, clung on, but of course explains nothing. Moreover, as Wundt pointed out, language change is a social phenomenon and cannot be explained by random changes in the habits of an individual. The *Wellentheorie*, according to which changes radiate from one centre along certain lines of communication seemed to afford a bridge from individual to social change. However one is still left with a number of uncertainties. Is it a new form or a new norm that spreads in this way ? And at the end we have still an account not an explanation both of an original change and its subsequent spread.

A long-lived French tradition, deriving to some extent from Schuchardt and developed by Meillet, has been to talk of immanent " tendencies " of a language, covering a wide range of particular sound changes over as long a period of time as possible. Prokosch (1939) quotes Vendryès: —

" Tout changement phonétique peut être considéré comme dû à l'action de forces

intimes et secrètes auxquelles convient assez bien le nom de tendances. Ce sont ces tendances qui modifient sans cesse la structure de la langue, et l'évolution de chaque idiome résulte en dernière analyse d'un jeu perpétuel de tendances.... La notion de tendance phonétique est plus exacte théorétiquement, et pratiquement plus féconde que celle de loi phonétique. Elle seule permet de déterminer avec précision la cause des changements phonétiques et d'interpréter scientifiquement ceux mêmes qui apparaissent les plus rebelles à toute discipline scientifique." And Prokosch himself says:— " The Phonetic Basis is the static, descriptive aspect of the acoustic character of a language, the Phonetic Drift its dynamic, historical aspect. . . . Phonetic Laws are merely its component parts."

But the capital letters in which these terms are enshrined are evidence of the highly mystical nature of the conceptions involved in such theories. It is not easy to see how, in language, any but a conservative traditional force could operate over a period of time involving many generations. To motivate a drift, a condition of permanent imbalance, it is necessary to demonstrate the presence of some permanent motive force operative within a community the whole time, which produces an instability, and evokes a movement to restore stability, which in turn is only partial. Some stronger evidence than capital letters and speculation on the general character of a language or the people speaking it would seem to be required.

Prokosch ultimately states that the Drift must be regarded as a description of the changes involved not an explanation.

Can the results of structural analysis assist towards this end ? The answer of Paul, Bloomfield and de Saussure was unanimous and unambiguous: No. Bloomfield (1933) stated flatly: " The causes of phonetic change are unknown ", and simply enumerated types. Paul wrote:— " Die descriptive Grammatik verzeichnet, was von grammatischen Formen and Verhältnissen innerhalb einer Sprachgenossenschaft zu einer gewissen Zeit üblich ist, was von einem Jeden gebraucht werden kann, ohne vom Andern missverstanden zu sein und ohne ihn fremdartig zu berühren. Ihr Inhalt sind nicht Tatsachen, sondern nur eine Abstraktion aus den beobachteten Tatsachen. Macht man nun solche Abstraktionen innerhalb der selben Sprachgenossenschaft zu verschiedenen Zeiten, so werden sie verschieden ausfallen. Man erhält durch Vergleichung die Gewissheit, dass sich Umwälzungen vollzogen haben, man entdeckt wohl auch eine gewisse Regelmässigkeit in dem gegenseitigen Verhältnis, aber über das eigentliche Wesen der vollzogenen Umwälzung wird man auf diese Weise nicht aufgeklärt. Der Kausalzusammenhang bleibt verschlossen, so lange man nur mit diesen Abstraktionem rechnet als wäre die eine wirklich aus der andern entstanden. Denn *zwischen Abstraktionen gibt es überhaupt keinen Kausalnexus, sondern nur zwischen realen Objekten und Tatsachen.*"

The sense of the powerlessness of the individual vis-à-vis " la langue emmagazinée dans les cerveaux de tous les membres d'un communauté " paralyzed de Saussure in this field. He could envisage no mechanics of change in an *état de langue,* and regarded it as an automatic function of time acting on the " masse parlante "

As the linguistic sign is arbitrary, the preservation of forms depends upon imitation. This is imperfect and changes creep in which are irreversible, precisely because they are immotivated. The changes which occur, the phonetic changes at any rate, affect the substance of speech—habits of articulation and the consequent sound qualities produced. Since sounds are distributed in an arbitrary fashion and develop identically, they bring about certain haphazard, unpredictable changes in a language system, but occur independently of systemic considerations. " L'opposition entre les deux points de vue—synchronique et diachronique—est absolue et ne souffre pas de compromis ". " Un fait diachronique est un évènement qui a sa raison en lui-même ; les conséquences synchroniques qui peuvent en découler lui sont complètement étrangères ". " La modification ne porte pas sur l'agencement mais sur les éléments agencés ". " Jamais le système n'est modifié directement ; . . . seuls certains éléments sont altérés sans égard à la solidarité qui les lie au tout." Then an example from Old English: " pour exprimer le pluriel il faut l'opposition de deux termes: ou *fót: fóti* ou *fót fét*: ce sont deux procédés également possibles, mais on a passé de l'un à l'autre pour ainsi dire sans y toucher ; ce n'est pas l'ensemble qui a été deplacé ni un système qui a engendré un autre, mais un élément du premier a été changé, et cela a suffi pour faire naître un autre système. Cette observation nous fait mieux comprendre le caractère toujours *fortuit* d'un état " (de langue). De Saussure's influence in this respect has been less, perhaps because Meillet, working still with the underlying drive of the tendencies theory, dissented. Meillet taught that " chaque langue forme un système où tout se tient ", and consequently no change had meaning unless related to the system.

This view was endorsed by the decision of the First International Congress of Linguists[1] and explicitly formulated by Hjelmslev. " La linguistique metachronique... procède par juxtaposition explicative de plusieurs systèmes successifs ". The development of Trubetzkoy's phonology placed a tool in their hands and as a result it became possible to deal with systems of phonemes instead of single phonemes. First Fourquet (1948) showed the need for remembering that language is working the whole time so that correlations tend to be constantly maintained. " Maintenant que les travaux de l'école phonologique ont sensibilisé les spécialistes " he wrote, " nous ne doutons pas qu'on ne découvre des faits de cet ordre (l'évolution de correlation) dans l'histoire de toutes les langues du monde."

The method is to analyse phonemes into their system of relations, and to show the resulting degree of integration. The more integrated and symmetrical a system the greater its stability unless disturbed from outside. This is because fewer distinctive features are involved with consequent easing of mental effort. Where some imbalance occurs subsequent developments tend to even it out. This results in greater " economy ", that is balance between the conflicting demands of communication, which requires the maintenance of distinctions, and inertia, which tends to blur them. These concepts

[1] *Cf. the account by R. Jakobson in N. S. Trubetzkoy,* Grundzüge der Phonologie, *2nd ed., Halle, 1958.*

have been developed by Martinet, in whom many traditions (but not the neo-grammarian) converge. An Anglo-Saxon is taken aback by his repeated ascription of motives to languages and systems, which the French language more or less forces on him, but under it is a fruitful concept which supplies a dynamic, though a restricted one. I think for example that it would be useful to look at the assembly of voiced fricatives in Modern German in this light.

VI

Is the answer to Lane's query at the end then to be a negative one ? Is historical phonology too fraught with uncertainty, too remote and static to compete with the vigorous descriptive study of living language ? There can be little doubt that the systematic study of living language is, and will continue to be, of central importance. On the other hand, can a purely descriptive science which ignores progress, change and development remain satisfying for long ? I do not think so. We must recapture a dynamic of language development, and free linguists from the rigor of the *état de langue*. But we shall only understand the process of change if we can see it at work ; we shall not do this by deducing its final products from historical texts, nor by allowing the tide of change to swirl about us, but only by organising our observations over a period of time in the light of a coherent theory. This theory will owe much to the results of traditional historical study which will show us what we should look for, what factors we can expect to be operative. In return the observation of change in progress will provide a greater understanding of the past. To quote Fourquet again : — " il faut que les premières lois aient été établies par l'étude des langues vivantes pour qu'il vaille la peine de poser les questions de cause ".

In this task, we should take note of other aspects of social biology, or ecology. We need to trace the various dimensions along which speech habits vary within a given community ; the range of stylistic variation, of regional and class variation, among others. We have then to express in statistical terms the distribution of a population along these axes, to observe changes and identify the types of selection pressure which have operated.

Stylistic variation at the phonetic level is clearly related to the requirements of communication between speaker and listener in different social contexts. A formal style, appropriate to a monologue delivered to many strangers, shows a maximal phonetic separation of forms, whereas a familiar style, appropriate where conversation partners are in intimate two-way contact and know well what to expect of each other, shows considerable phonetic reduction of redundancy by assimilation, elision, and vowel weakening, all of which reduce, eliminate or slow down the movements of the organs of speech.

A range of this sort will be maintained permanently within every speech community, but changes are to be expected in the social contexts in which a particular style is found appropriate.

Where variation has class connotations, changes in distribution will depend on changes in class structure, class mobility and in attitudes towards class differences. Here conscious choice is possible and likely. If a range of variation is perceived, a speaker can extrapolate by a sort of analogy. I think, for example, that it is possible to relate most recent changes in general middle class London English to reaction against Cockney.

In this way " new " forms can be evolved, for unlike the objects of biological selection, language is not genetically determined, nor reliant on random mutations for the supply of new forms. Change and the adaptation to new conditions is more rapid.

Geographical variation over an area is in proportion to the state of communications. The relation is however mostly indirect. Deteriorating communications, due to the diffusion of a hitherto compact group over a wide area, or to a recession of civilisation, allow different pressures to come into operation in different areas. Improving communications bring people into contact with a greater variety of usage, providing a more open field for the operation of selection pressures, which are however likely to operate more uniformly, decreasing the range of variation.

Variation between age-groups may be an index of language change, but not necessarily. Each man in his time speaks many languages. We all squeak in infancy and quaver in age. A community may maintain age-group languages intact for a long time. Infant learning of speech is undoubtedly of importance in the operation of analogy and structural pressure, both of which reduce specific learning in relation to general learning. But its role in linguistic change should not be over-estimated. There is a strong pressure to suppress infantilisms after the age of, say 5, when the play group and adolescent gang demand conformity. They in turn develop an individual stamp based on tough dialect and secret language. Adult habits show greater stability. It is possible to tell a person's age within fairly close limits not only from physical changes and archaisms, but because style and appropriate usage change.

At each stage, change in the individual is required to preserve continuity in the community. Stability in the individual may mean change in the community.

The discipline of the community is effected by the fact that the older children are few in number and are assimilated into a predominantly stable adult community. This powerful conservative force is reinforced institutionally in numerous ways, and itself reinforces with a drive to " correctness " the continuity inherent in the need for comprehension.

The study of variation within a speech community and its function may be called linguistic ecology, after the comparable branch of biology. Its essence lies in regarding the balance of co-existent competing forms as the basis of a dynamic linguistics.[1]

Unfortunately, it is clear that a written language will mask this variety rather than

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[1] H. L. *Koppelmann*, Ursachen des Lautwandels (*Leiden, 1939*) *develops a theory of sound-change by selection. The work is anecdotal in character, but contains many stimulating suggestions.*

reveal it, and the application of the results to historical material will require delicate handling. However, the contribution by Prof. Prins (1958) to the Oslo Congress shows how fruitful the concept can be.

An important aspect is to determine the principles according to which one variety is chosen as the basis for a written language. It is unlikely, for instance, that clerical OHG, courtly MHG and bourgeois NHG represent any straight line of development. Their discontinuity may mark simply a change of selection.

However, the basis of a theory of processes must be the study of living language, and here one may cite Abrahams, *Tendances Evolutives des Occlusives Germaniques* as a pioneering work, analysing in depth the range of the articulation of plosives in Copenhagen. What is required is a new type of dialect survey, aiming not at the capture of linguistic Coelecanths but at an analysis in depth of linguistic variety.

And if I may close by appropriating Roman Jakobson's (1958) words at Oslo:

" Herewith the myth of change and permanence, both due to the fortuity of blind and aimless chance, irrevocably fades away. Permanence, statics in time, becomes a pertinent problem of diachronic linguistics while dynamics, the interplay of subcodes within the whole of a language, grows into a crucial question of linguistic synchrony "

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THE HAPAX LEGOMENON: A REAL OR APPARENT PHENOMENON ?

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This paper discusses the question whether hapax legomena—words occurring only once in a sample—are also unique in a larger corpus from which the sample is taken. The discussion requires a knowledge of how words with a specific frequency of occurrence in the total are distributed in samples and this problem is treated empirically and theoretically. As a result, a general answer to the central question is advanced.

The title chosen for this paper was suggested some years ago by Whatmough (mentioned in Whatmough, 1956). It appears that he regarded the entire notion of hapax legomenon as something of a mirage, although the fact mentioned by him that many of the once-words in Catullus were hapax legomena for the entire corpus of Latin literature, would seem to point in the opposite direction. However, this is the type of problem whose solution requires the use of quantitative methods on a large scale.

1

Hapax legomena are words occurring once only in a given sample of the spoken or written language. That sample may be part of a larger unit, or the whole of it, and thus a text unit itself, or it may comprise parts of different such units, i.e. as a composite sample. The question of whether hapax legomena are ' real ' can only have one legitimate meaning, viz. whether the singularity of occurrence in a given sample of the language reflects singularity also in the larger unit of which a given sample forms part. It does not necessarily mean that the word has occurred once only in the whole history of the language, but must be always understood relative to a given corpus, whatever its size.

If by ' real ' in this connection we mean that a sample hapax legomenon is also one in the total from which the sample was drawn, or, in other words, that the hapax legomenon property in the sample reflects the uniqueness of the word in question in the total, then ' apparent ' must mean that a sample hapax legomenon does not reflect that property of the word in the total, from which it follows that to that extent the

hapax legomenon property in the sample is due to the distribution of words with other frequencies in the total.

The answer to the question put in the title requires, therefore, as an intermediate step a knowledge of how words with specific frequencies in the total distribute themselves in samples. This problem will be dealt with first empirically (sections 1 and 2) and then theoretically (section 3), after which a general answer to the main problem will be given (sections 4 and 5).

The result of the intermediate investigation is itself linguistically relevant, since it provides evidence of a chance distribution mechanism of the words of a language among samples from it. Some of these results will come as a surprise to the more deterministically minded linguist: the number of words peculiar to a sample is very much the same in samples of the same size ; and similarly for words peculiar to any two samples, and words peculiar to any three samples, and so on. This seems to point to a distribution mechanism designed so as to maintain a fair balance between uniformity and diversity of vocabulary between the samples, beyond the individual choice of the writer.

In order to give an objective answer to the question which forms the title of this paper, we shall use word counts of nouns by Yule (1944) made for quite a different purpose, but very suitable for our problem. Our material will consist of three series of data: 4 spatially different samples from the same work, Macaulay's essay on Bacon ; samples from 4 different essays by Macaulay: on Milton, John Hampden, Frederick the Great, and the total count from the essay on Bacon ; and samples from 4 works by Bunyan (The Pilgrim's Progress, Part I, The Pilgrim's Progresss, Part II ; The Life and Death of Mr. Badman ; The Holy War). Since the first group of 4 samples represents one particular text, the second group 4 different texts, but of the same literary genre, and the third 4 different works by the same author, there is sufficient variation in the relation of the smaller to the larger unit to warrant reasonable generality for our conclusions. For each of the three series we shall consider the hapax legomena in the total (all 4 samples, all 4 essays, and all 4 works) in relation to the hapax legomena in each of the samples, essays, and works.

2

We shall use the following notation. The capital A (positive symbol) denotes 'noun occuring in sample A' the corresponding Greek letter α (negative symbol) 'not occurring in sample A', and so on ; a class symbol like ABCD denotes 'occurring in all 4 samples A,B,C, and D'; ABCδ 'occurring in A,B and C, but not in D'; AβCδ 'occurring in A and C, but not in B and D', and so forth. There are 4 letters in each class symbol of Table 1, and each letter may be either a capital or a Greek letter, so there must be in all 2^4, or 16 classes.

A class frequency is denoted by putting the class symbol in brackets, e.g.

$$(\alpha\beta\gamma\delta) = 0$$

According to the number of letters within the brackets, we speak of first order, second order, third order and fourth order frequencies. A symbol like (A) is a first order frequency and means all words occurring in sample A, regardless of whether they also occur in any of the other samples ; a symbol like (BC) denotes a second order frequency and means all the words occurring in B and C, regardless of whether they occur in A and D.

Table 1 shows, in the columns headed 'Observed', the distributions of the total vocabulary over the 16 word-classes in the 4 samples from Macaulay's essay on Bacon, the 4 essays by Macaulay, and the 4 works by Bunyan. The explanation of the columns headed 'Expected' will follow.

TABLE 1

1	2	3	4	5	6	7	8
		Essay on Bacon		Macaulay		Bunyan	
	Class	Expected	Observed	Expected	Observed	Expected	Observed
1	ABCD	277.51	271	607.25	402	449.17	259
2	ABCδ	61.60	62	43.21	55	75.64	82
3	ABγD	61.60	58	154.17	132	75.64	92
4	AβCD	61.60	53	154.17	144	75.64	66
5	aBCD	61.60	64	154.17	140	75.64	51
6	ABγδ	71.58	68	70.48	79	76.02	111
7	AβCδ	71.58	64	70.48	100	76.02	83
8	AβγD	71.58	59	184.17	178	76.02	50
9	aBCδ	71.58	67	70.48	74	76.02	63
10	aBγD	71.58	66	184.17	168	76.02	65
11	aβCD	71.58	81	184.17	173	76.02	74
12	Aβγδ	273.66	268	319.12	447	259.53	262
13	aBγδ	273.66	280	319.12	283	259.53	297
14	aβCδ	273.66	275	319.12	457	259.53	352
15	aβγD	273.66	312	708.72	711	259.53	339
16	aβγδ	—	—	—	—	—	—
Total	—	2048.03	2048	3543.00	3543	2245.97	2246

The observed class frequencies of the fourth order compared with those expected on the basis of random partitioning.

Careful inspection of Table 1 reveals a remarkable similarity in the runs of frequencies in columns 4, 6, 8. In each, the classes with the highest frequencies are (1) the leading class ABCD of nouns common to all 4 samples, and (2) the classes Aβγδ etc. of nouns peculiar to a single sample, which we shall also briefly refer to as one-class words or one-sample words. To bring this trend out more clearly, we average the three groups formed by lines 2-5, 6-11, 12-15 of Table 1, which gives the mean frequency of classes of words common to four, three or two of the samples, or peculiar to one sample. These means are shown in Table 2.

TABLE 2

1	2	3	4	5
Lines of Table 1	Words common to number of classes	Four samples of essay on Bacon.	Four essays of Macaulay.	Four works of Bunyan.
1	4	271.00	402.00	259.00
2-5	3	59.25	117.75	72.75
6-11	2	67.50	128.67	74.33
12-15	1	283.75	474.50	312.50

Moreover, if we now pick out from Table 1 the 8 classes of the fourth order which together make up any one class of the first order, we find that the frequencies (ABCD) and (Aβγδ) taken together contribute one-half or more of the total (A), and similarly the frequencies (ABCD) and (αBγδ) one-half or more of the total (B), and so forth. That is to say, one-half or more of all the nouns in any one sample is contributed by (1) nouns common to all 4 samples and (2) nouns peculiar to that particular sample Table 3 gives the percentages of the form

$$100 \; \frac{(ABCD) + (Aβγδ)}{(A)}$$

For example, from col. 4, Table 1, we have

$$(ABCD) \quad = \quad 271$$
$$(Aβγδ) \quad = \quad 268$$
$$(A) \quad = \quad 271 + 62 + 58 + 53 + 68 + 64 + 59 + 268 = 903$$

and the ratio

$$(271 + 268)/903 \quad = \quad 59.7\%$$

From col. 6, Table 1, we get the corresponding ratio as

$$(402 + 447)/1537 \quad = \quad 55.2\%$$

and so on.

TABLE 3

1	2	3	4
Class	Four samples from essay on Bacon	Four essays of Macaulay	Four works of Bunyan
A	59.7 (58.1)	55.2 (57.8)	51.8 (60.9)
B	58.9 ,,	51.4 ,,	54.5 ,,
C	58.3 ,,	55.6 ,,	59.3 ,,
D	60.5 ,,	54.3 (56.5)	60.0 ,,
Average	59.4	54.1	54.4

The percentages of words common to the four samples, together with words peculiar to each sample, over the total for each of the samples A, B, C and D of Table 1. The figures in brackets are the expected percentages.

3.

The uniformity is so striking that it looks as if we ought to be able to account for it by some purely statistical reasoning.

Let us consider a text as a linear sequence of 100,000 words, which is divided into 100 samples of 1000 words each. If a word occurs once only in the total, the probability of its appearing in one sample is 0·01 and, consequently, that of not appearing, 0·99 ; the probability of its appearing in one or the other of two samples is, by the addition theorem of probability, 0·01 + 0·01 = 0·02, and that of not appearing, 0·98 ; the corresponding probabilities in the case of three samples are 0·03 and 0·97.

In general, for r samples, the probability of the word appearing in one of k samples is k/r, and that of its not appearing in k samples

$$\frac{r - k}{r} \tag{1}$$

The most convenient set of quantities for our purpose is that of the probability of non-appearance, from which the probabilities, and expected numbers of words in the various classes, can easily be obtained.

If the word occurs twice in the language, the above probabilities for appearance and non-appearance in a sample apply for each occurrence of the word, and the probability of neither of the two occurrences appearing in one sample is then, by the multiplication theorem of probability, $(0·99)^2 = 0·98$; in two samples $(0·98)^2 = 0·96$; in three samples $(0·97)^2 = 0·94$. If the word occurs three times in the language, the respective probabilities of its non-appearance in one (two, three) sample(s) are $(0·99)^3 = 0·97$, $(0·98)^3 = 0·94$, and $(0·97)^3 = 0·91$.

Generally, for x occurrences and r samples, the probability of non-appearance in k samples is

$$\left(\frac{r - k}{r} \right)^x \tag{2}$$

If there are f_x such words (the sum of all $x f_x$ being the number of words in the total, 100,000 in our illustration), the expected number of them not appearing in any of the k samples is therefore

$$f_x \left(\frac{r - k}{r} \right)^x \tag{3}$$

and the entire number of words not falling into any one of the k samples is the sum of such expressions for all values of x

$$\int \left\{ f_x \left(\frac{r - k}{r} \right)^x \right\} \tag{4}$$

The random distribution of vocabulary may be visualised more clearly by the following experimental demonstration. Let us suppose we write out all the nouns of the total frequency distribution of words from Macaulay's essay on Bacon on counters, giving a noun that occurs x times x counters, and then deal them at random

into four trays labelled A, B, C and D. To ensure approximate randomness we might toss the counters into a spinning circular tray with four equal quadrants A, B, C and D. Sorting the counters in each quadrant by nouns, and listing and counting the *nouns* in each—not the number of counters—we shall then have word classes like those of column 4, Table 2. The most convenient way is to calculate the set of frequencies for the negative classes, those the symbols for which consist entirely of Greek letters. Supposing our circular tray is not divided into four, but into r equal sectors, the numbers *expected* on pure chance to fall into the classes ABCD, ABCδ, etc. are determined as follows. The chance of a word entered on x counters not falling into any one of k named sectors is given by formula (2). If there are f_x such words, the expected number of them not falling into any one of the k named sectors is given by (3), and the entire number of counters not falling into any one of the k named sectors is the sum of such expressions for all values of x from unity to the maximum value in the frequency distribution, that is to say, the frequency of negative classes of the k-th order, as given by (4).

The arithmetic is most briefly and simply carried out directly as indicated by this equation. With $r = 4$, as in our experimental material, we evaluate the three frequencies

$$(\alpha) \ = \ S\left\{\ f_x(\tfrac{3}{4})^x\ \right\}, \qquad (\alpha\beta) = S\left\{\ f_x(\tfrac{1}{2})^x\ \right\}, \qquad (\alpha\beta\gamma) = S\left\{\ f_x(\tfrac{1}{4})^x\ \right\} \qquad (5)$$

which actually give us fourteen frequencies since $(\alpha) = (\beta) = (\gamma) = (\delta)$, and so forth. We know the value of N (the total number of nouns in the frequency distribution) and are also given $(\alpha\beta\gamma\delta) = 0$, and can then calculate the complete set of fourth-order frequencies, or the frequencies of the positive classes or any other set we like. But simply for the sake of more clearly exhibiting how (ABCD), (ABCδ), (AB$\gamma\delta$) and (A$\beta\gamma\delta$) are built up—and we need only concern ourselves with these four since obviously (ABCδ) = (ABγD) = (AβCD) = (αBCD) and so on—we shall calculate these fourth-order frequencies direct from the frequency distribution. The equations, derived from equations (5), are

$$(ABCD) \ = \ S\left\{\ f_x\ [1\ -\ 4(\tfrac{3}{4})^x\ +\ 6(\tfrac{1}{2})^x -\ 4(\tfrac{1}{4})^x]\ \right\}$$

$$(ABC\delta) \ = \ S\left\{\ f_x\ [(\tfrac{3}{4})^x\ -\ 3(\tfrac{1}{2})^x\ +\ 3(\tfrac{1}{4})^x]\ \right\}$$

$$(AB\gamma\delta) \ = \ S\ \}\ f_x\ [(\tfrac{1}{2})^x\ -\ 2(\tfrac{1}{4})^x]\ \right\}$$

$$(A\beta\gamma\delta) \ = \ S\left\{\ f_x\ (\tfrac{1}{4})^x\ \right\} \qquad (6)$$

For once-words, in particular, the last line of formula (6) gives the expected frequency of such words in each sample as 1/4 of the hapax legomena in the total. For practical work with the random partitioning function, whose calculation according to the above formula soon becomes laborious, especially for a greater number of parts or samples and higher frequencies of words, the reader is referred to a forthcoming book[1] which has a numerical table from which the probability of a word with frequency $x = 1$ to $x = 100$ occurring in $1, 2 \ldots 30$ parts can be read off directly. This saves most of the labour in calculating the random partitioning of numbers.

[1] G. Herdan : Type-Token Mathematics, *Mouton & Co., The Hague.*

Table 4 gives the results for the material cited in this paper, the figures in each of columns 2-5 being the product of f_x by the numerical coefficients of equations (6).

TABLE 4

1 X	2 (ABCD)	3 (ABCδ)	4 (ABγδ)	5 (Aβγδ)	6 Check total
1	—	—	—	247.50	990.00
2	—	—	45.87	22.94	366.98
3	—	16.22	16.22	2.70	173.00
4	10.50	15.75	6.13	.44	112.04
5	16.87	10.55	2.11	.07	72.01
6	17.90	6.20	.71	.01	47.00
7	21.02	4.52	.32	.00	41.02
8	19.31	2.74	.12	.00	30.99
9	24.19	2.35	.07	.00	34.01
10	13.27	.91	.02	.00	17.03
11	20.02	.98	.01	.00	24.00
12	16.62	.59	.00	.00	18.98
13	9.06	.23	.00	.00	9.98
14	9.29	.18	.00	.00	10.01
15	12.31	.17	.00	.00	12.99
16	2.88	.03	.00	.00	3.00
17	9.70	.07	.00	.00	9.98
18	6.84	.04	.00	.00	7.00
19	5.90	.03	.00	.00	6.02
20	4.94	.02	.00	.00	5.02
21	0.99	.00	.00	.00	0.99
22	3.97	.01	.00	.00	4.01
23	6.97	.01	.00	.00	7.01
24	1.99	.00	.00	.00	1.99
25	1.00	.00	.00	.00	1.00
26	4.99	.00	.00	.00	4.99
27	2.99	.00	.00	.00	2.99
28	3.99	.00	.00	.00	3.99
29	1.00	.00	.00	.00	1.00
30 up	29.00	·.00	.00	.00	29.00
Total	277.51	61.60	71.58	273.66	2048.03

Calculation of the expected class frequencies (ABCD), (ABCδ), (ABγδ) (Aβγδ) by random partitioning from the combined word count for the samples from Macaulay's essay on Bacon Col. 6 gives a check total which should reproduce f_x within the limits of errors of rounding off. In cols. 2-5 a dash signifies zero, and 0·00 'less than 0·005'.

In the same way the theoretical frequencies are calculated for the series of samples from four essays by Macaulay and for that from four works by Bunyan. The calculated frequencies are entered under the heading 'Expected' in cols. 3, 5, 7 of Table 1. There is, on the whole, good agreement between 'observed' and 'expected'

frequencies. To exhibit that agreement more clearly, we now calculate the percentages of Table 3 from the expected frequencies:

(1) *Macaulay's essay on Bacon.*

$$100 \, [(ABCD) + (A\beta\gamma\delta)] \, / \, (A) \; = \; 100 \, (277 \cdot 51 + 273 \cdot 66)/950 \cdot 71 \; = \; 58 \cdot 1\%$$

The same percentage applies to the other three samples B,C,D. The calculated percentage is close enough to the average of the observed figures: 59·4%

(2) *Four essays by Macaulay.*

For each sample, A,B,C we have

$$100(607 \cdot 25 + 319 \cdot 12)/1603 \cdot 05 \; = \; 57 \cdot 8\%$$

as against an observed average of 54·1%.

For sample D we have

$$100(607 \cdot 25 + 708 \cdot 72)/2330 \cdot 99 \; = \; 56 \cdot 5\%$$

as against the observed 54·3%.

(3) *Four works by Bunyan.*

For each sample A,B,C,D we have

$$100(449 \cdot 17 + 259 \cdot 53)/1163 \cdot 68 \; = \; 60 \cdot 9\%$$

as against the observed average of 54·4%.

4.

For our immediate purpose—the hapax legomena problem—we consider the number of once-words in connection with that of words occurring in one sample only. Looking at Table 4, we find that 247·5 of the 273·66 words which are peculiar to a sample, that is 90·5%, are accounted for by the hapax legomena in the total.

A word occurring once only in the total can only occur in one sample, and must thus of necessity belong to the class of the form $A\beta\gamma\delta$; moreover, it must also be a sample hapax legomenon. The reverse is not true: a word occurring in the number $(A\beta\gamma\delta)$ need not be a once-word in either total, or sample. *The proportion of the number $(A\beta\gamma\delta)$ which is accounted for by hapax legomena in the total consists therefore of hapax legomena in the sample ; these are 'real' in the sense that they are also hapax legomena in the total.*

The relevant quantities for the three series are listed in Table 5. The numbers of one-sample words in each series are the sums of the last four entries in cols. 3,5,7 of Table 1, for 'Expected', and in cols. 4,6,8 for 'Observed' frequencies. The observed number of once-words (hap. leg.) in each series are 990 for the 4 samples from Macaulay's essay on Bacon, 1,460 for the samples from four essays by Macaulay, and 931 for the samples from 4 works by Bunyan (Yule's tables 4·4, 6·4, 6·7). Since according to formula (6) the expected number of once-words in a sample is 1/4 of those in the total, these figures represent also the *expected* number of once-words in the three series.

TABLE 5

	Once-words	Observed One-sample words	Percentage	Expected Once-words in the total	One-sample words in A, B, C & D	Percentage
4 samples from essay on Bacon.	990	1135	87.2%	990	1094	90.5%
4 essays by Macaulay	1460	1666	87.3%	1460	1898	76.9%
4 works by Bunyan	931	1250	74.4%	931	1038	89.7%

In the four sample series from the essay on Bacon we find that the 990 hapax legomena in the total distribute themselves so as to account for 87·2% of the one-sample words, $268 + 280 + 275 + 312 = 1135$. This means that as to about 90% the $(A\beta\gamma\delta)$ numbers consist of hapax legomena in the sample which are also hapax legomena in the total, and therefore 'real'. This proportion is sufficiently close to that to be expected under the assumption of random partitioning of nouns, viz. 90·5%, to justify the conclusion that the distribution of the 990 hapax legomena among the four samples is, by and large, the result of random partitioning. Similarly, we find that the one-sample words in the samples from four essays by Macaulay are as to 87·3% accounted for by hapax legomena in the total which, of necessity, are also hapax legomena in the samples, as against an expectation of 76·9% on random partitioning. For the four works by Bunyan we find the hapax legomena part of the $(A\beta\gamma\delta)$ group to be 74·4% as against an expected 89·7%.

As one might expect, there is a slight increase in the difference between observed and expected magnitude of the hapax legomena part of the one-sample words as we proceed from the samples of one essay by Macaulay to samples of four of his essays, and from there to samples of four different works by Bunyan. But, by and large, the conclusion holds that the hapax legomena in the total account for a great part of the hapax legomena in the samples, namely as far as the latter are also one-sample words; moreover, the occurrence of hapax legomena in the partial distributions can be accounted for to that extent by a statistical mechanism, and thus by chance.

However, just as a one-sample word need not be hapax legomenon in the total, so a sample hapax legomenon need not be a one-sample word: it may be a once-word in more than one sample. The percentage of *all* sample hapax legomena which is accounted for by those in the total results for our three series as follows:

Samples from essay on Bacon   : $990/2296 = 43·2\%$
  ,,   ,,   4 essays by Macaulay : $1460/3427 = 42·6\%$
  ,,   ,,   4 works by Bunyan   : $931/2084 = 44·7\%$.

5.

To sum up in terms of the question put at the beginning:

1. The hapax legomena in a literary text play a characteristic role in the vocabulary structure of text samples. The group of words peculiar to a sample is in our material made up as to something like 70-90% by hapax legomena in the total text. That part of the one-sample word group represents also sample hapax legomena. The latter are thus seen to be partly identical with the hapax legomena in the total, and in so far 'real', and partly words with other frequency of occurrence in the total text.

If the question in the title is put as "How rare are rare words ?", the answer is, for our material, that of the words peculiar to a sample between 70% and 90% are extremely rare, but that 10% to 30% of "rare" words are not so rare.

2. The extent to which the hapax legomena in the total account for words peculiar to one sample, the $A\beta\gamma\delta$ class of word, and the extent to which the hapax legomena in the sample are 'real', depends upon
   a. the number and size of the samples ;
   b. the homogeneity of the distributions, whether they are samples from the same or different texts, the same or different writers etc.

It is, however, of interest in this connection that the ratio calculated for the whole of the Greek New Testament and for the Pauline letters is very similar, in spite of the great difference in text length, and in frequency distribution between these works, on the one hand, and between both of them and the material used in this paper (see Table 6).

TABLE 6

	New Testament	Pauline letters
Text length (no. of words)	137,328	32,303
One-sample words	2,626	1,415
Hapax legomena	1,934	1,140
Ratio hap. leg./One-sample words	72.7%	80.6%

3. The observed percentages of one-sample words ($A\beta\gamma\delta$), which are hapax legomena in the total—and thus of necessity also in the sample—agree so closely with those calculated by the statistical mechanism of random partitioning, that we may regard the occurrence of hapax legomena among the one-sample words as the result of chance, i.e. of random partitioning of the hapax legomena in the total among the

samples. Heterogeneity of text samples may result in appreciable differences between the observed and expected numbers of hapax legomena, which can be used as a stylo-statistical criterion.

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BEHAVIOURISM AND LINGUISTICS: AN HISTORICAL NOTE

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Behaviourism provided a framework within which language could be discussed without presupposing words to be the vehicles of "thought." Consequently behaviourism created a more favourable intellectual milieu for modern linguistics than did the earlier school of structural psychology. To appreciate the significance of this shift in outlook, one must trace the influence of philosophical empiricism upon the development of experimental psychology, for only by doing so can we understand why psychology was able to exert a conservative influence upon linguistic studies and why that influence abruptly vanished after the First World War.

Descartes helped to implant in Western philosophy the doctrine, known as dualism, that mind can be considered, apart from the body, as a distinct entity whose properties can be investigated and related to the sphere of physical substance. He also postulated the existence of "innate" ideas, which are present in the mind, although not derived from experience. Locke, and the subsequent school of British Empiricism, accepted the dualistic distinction between mind and body, but rejected the doctrine of innate ideas. Hence epistemology resolved itself into the question of how we come to perceive the external world. Eventually, John Stuart Mill answered this question by asserting that various discrete sensations were the elements which compounded to form our perceptions of external reality. Structural psychology adopted both Cartesian dualism and an elementalistic theory of perception based upon that of John Stuart Mill. Later, however, the schools of Gestalt psychology and behaviourism came into being as protests against the older tradition. The former retained a dualistic distinction between mind and body, but discarded the elementalistic view of perception, whereas the latter set aside dualism entirely and regarded behaviour as the only proper subject-matter for psychological study.

Leonard Bloomfield's work has been of prime importance in the development of modern linguistics. In 1914 he evidently accepted the assumptions of structural psychology, viewing language as largely a resultant, albeit also partly a determinant of, the mechanism of perception. Within two years, however, he had moved towards a recognition of the fundamental weakness of such assumptions: namely, their rather too rigid insistence that all perceptual experience is composed of various discrete units. It was William James' criticism of structural psychology that had prompted Bloomfield to reconsider his own position. Gestalt psychology might well have been accepted as a more fruitful theoretical foundation for linguistics, inasmuch as it fully recognized and attempted to solve the problems with which Bloomfield had begun to grapple. But in fact, behaviourism provided a more direct pathway to the desired goal, since it eliminated Cartesian dualism and the elementalistic theory of perception along with it. Consequently linguistic studies could proceed without relating the observed phenomena to any theory of the supposed structure of the mind or the presumed mechanisms of perception underlying verbal behaviour. The most far-reaching result

of this new freedom is the now-familiar assumption that linguistic study must begin with the phonology of the language under consideration, and then proceed to describe the morphological and syntactic features in terms of structure within the system, rather than in terms of any causal interrelationships between such formal features of the language and the "mental life" of the speech community in question. Moreover, underlying that assumption, and necessary to it, are the concepts of the phoneme and the morpheme, both of which were far less tenable, if not impossible, within the framework of structural psychology.

PHILOSOPHICAL BACKGROUND

Descartes shares a prominent place in the roster of those thinkers to whom modern psychology owes its being, for his philosophy delineated certain problems that have been the continuing concern of psychologists, while at the same time advancing solutions whose implications must still be dealt with.[1] One of the most influential aspects of Cartesian philosophy is its answer to the question of how the mind is related to the body. Descartes proposed the existence of two "substances." One, called "extended substance," comprised all the objects of the physical world. Dr. Johnson, kicking the stone in refutation of Bishop Berkeley, was then, according to this viewpoint, knocking together two bits of extended substance: his foot and the nearest rock. "Unextended substance," on the other hand, cannot be grappled with or bumped up against, although it is none the less real. The mind is unextended substance, and therefore not localized in space even though it does interact with the body. The locus of interaction was considered by Descartes to be the pineal gland, while the body itself was thought of as a kind of machine directed by the mind in much the same manner as a harpsichord is set in motion by its player. These concepts, vigorously propounded by Descartes, helped to firmly implant in Western philosophy the notion that mind, or consciousness, could be considered, apart from the body, as a distinct entity whose properties could then be investigated and related to the sphere of physical substance. This doctrine, known as dualism, has dominated psychological thinking until very recently.

Another central tenet of Cartesian philosophy is its postulation of "innate ideas." The ideas of self, God, space, time, and motion, as well as those of the geometrical axioms, for example, are all thought of as innately given rather than as derived from experience. Hobbes, and after him, Locke, opposed this doctrine. Locke, in his

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[1] *My discussion of the emergence of psychology from philosophy is based upon E. G. Boring's* History of Experimental Psychology. *A word of caution should be added here. I have been highly selective, attempting merely to indicate in summary fashion the origins of certain aspects of psychology that have influenced the field of linguistics. Consequently the reader who wishes a fuller understanding of the relationship between philosophy and psychology should consult Professor Boring's work. Moreover, I have not even touched upon the relationship between psychology and physical science, which is also discussed in Professor Boring's book; it has not seemed necessary for the purpose of the present study to do so.*

Essay Concerning Human Understanding, reasserted the Aristotelian conception of the mind as a *tabula rasa*: a blank tablet, as it were, written on by experience. Thus all the content of the mind was regarded as derived from experience, and hence perception was seen as the sole avenue of knowledge. Epistemology resolved itself into the question of how we come to perceive the external world. This question later became the primary concern of philosophy's thriving offspring, experimental psychology. Having advanced an empirical theory of knowledge, Locke next postulated the *idea* as the elementary unit of the mind, and proposed two sources for these units. The first is sensation, which comprises the qualities and images transmitted to the mind from the external world. The second is reflection, which is the process—a kind of inner sense—by which the mind comes to know of its own actions. Ideas, in turn, may be simple or, as a result of the combination of simple ideas, complex. Nevertheless, each complex idea may be analyzed into its component simple ideas. The principle of association was advanced to account for the compounding of simple into complex ideas, as well as for the successive association of ideas arising from their repeated juxtaposition.

Ironically, Descartes had provided the stimulus for Locke's underlying epistemological assumption, and hence also for the work of Berkeley, Hume, and Hartley, the leading figures of the school known as British Empiricism. It was Hartley who seized upon the notion of association as the principal law of mental life, thus firmly establishing the philosophy of Associationism which was brought to fullest development in the 19th century by James Mill and his son John Stuart Mill.

James Mill elaborated the notion of association into a theory of "mental compounding" which asserted that every complex idea is built up by the additive association of simple ideas that somehow retain their own properties even while forming a larger structure. For example, the complex idea of a brick house would be thought of as divisible into a finite number of simpler ideas such as those representing individual bricks, nails, window panes, and so forth. These unitary elements are subsumed under the more complicated idea, albeit without losing their individual characteristics. Presumably the idea of an ocean would consist of well-nigh innumerable simple ideas of water drops. Stated in such abbreviated terms Mill's theory seems even more starkly untenable than it is in fact. Its virtues, however, need not be dwelt upon here, because it is primarily important as a precursor of John Stuart Mill's more subtle concept of "mental chemistry." This refinement of his father's doctrine is best summarized in his own words. He wrote, in 1843, that

"It appears to me that the Complex Idea, formed by the blending together of several simpler ones, should, when it really appears simple (that is, when the separate elements are not clearly distinguishable in it) be said to *result from* or be *generated by,* the simple ideas, not to *consist of* them ... These are cases of mental chemistry: in which it is possible to say that the simple ideas generate, rather than that they compose, the complex ones." (Boring, 1950.)

In other words, the analogy of the chemical compound was considered applicable to

mental processes. Hydrogen has one set of properties and oxygen another. But the attributes of water cannot be considered to result from the additive combination of its two elementary components. Rather, the combination, although of distinct elements, results in a compound with an entirely different range of properties. Similarly, within the mind, sensations may enter into combinations which are perceived as complexes whose characteristics differ from those of their component elements.

An observation made by Professor Carroll is worth noting at this point. He writes that the mental chemistry evolved by the two Mills " ... seems to reflect its authors' observations of language phenomena, for complex thoughts might be represented by combinations of words and syntactical constructions showing the relations between the lower-order notions expressed by those words .... Nevertheless, these interpretations could hardly be said to rest on any sophisticated knowledge of language beyond the notions of subject, object, attribute, etc., popularized by grammarians " (Carroll, 1953). If this is so, as would seem to be the case, an interesting relationship emerges linking contemporary notions *about* language to the developing theories of mental processes. These theories, in turn, greatly influenced the new science of experimental psychology which, in the first decade of the twentieth century, helped reinforce the traditional view of language.

To understand why psychology was able to exert a conservative influence on the field of linguistics, as well as why that influence rather abruptly vanished after the First World War, it is necessary to briefly trace the emergence of experimental psychology as a separate field of study.

THE EMERGENCE OF EXPERIMENTAL PSYCHOLOGY

Wilhelm Wundt " ... is the first man who without reservation is properly called a psychologist " (Boring, 1950). The publication of his *Grundzüge der physiologischen Psychologie* in 1873-4 might be taken as marking the beginning of experimental psychology. Or one might fasten on the year 1879, which saw the founding of the first psychological laboratory, in Leipzig—where Wundt held a chair in philosophy. In any case, the significant fact is that Wundt, trained in both physiology and philosophy, linked the two fields to produce a new area of study. The growth of physical science after the Renaissance made some such union eventually inevitable. Wundt served as the catalyst responsible for the actual moment of fusion ; so at least it seems from the present vantage point.

By the turn of the century, the new experimental psychology forged by Wundt and his co-workers in Germany had assumed a definite shape and acquired a neatly defining label: it could appropriately be called, as it was by Titchener in 1898, a " structural " psychology. That is, it attempted to work out a " morphology of mind "[2] in terms of structure rather than to investigate the *uses*, or function, of the mind.

[2] *The phrase is Professor Boring's and may be found on p. 21 of his* History.

This latter task, however, was being attempted with some success in America. As a result, psychology in the New World turned to functionalism much earlier than it did in Europe.

Orthodox psychology of the Wundtian tradition accepted Cartesian dualism. Its method of investigation was *Selbstbeobachtung*: introspection carried out under carefully systematized experimental conditions, usually by trained observers. The object was to formulate a generalized portrait of the mind's structure. Yet, though it remained dualistic, structural psychology did not accept Descartes' belief in a causal interaction between mind and body. Instead, Wundt and his followers viewed the mind-body relationship as one of psychophysical parallelism. Mental events paralleled physical events, but there were no causal interconnections between the two, which were regarded as independent systems. Analogically, the situation might be represented by two watches which show the same time although they are in no way connected. However, correlations between mind and body could be, and were, studied to formulate a physiological psychology. But it was also possible to study mental events quite apart from any corresponding physical states. Structural psychology was elementalistic in its theory of perception since it accepted a mental chemistry based on that of John Stuart Mill. Sensations, images, feelings, and later, *Gestalt-qualität*, were the elements compounded to form our perceptions of the external world.[3] Finally, structural psychology was associationistic, since it accepted association from the British philosophers as the principle governing the compounding of elements into perceptions and meanings.

After 1913, however, two new schools of psychological thought developed and came to play dominant roles by the time of Wundt's death in 1920. Both originated as protests against the Wundtian tradition, but each took issue with a different aspect.

The first was Gestalt psychology, founded in Germany by Wertheimer, Köhler, and Koffka. It accepted the experimental method, as well as introspection. However, it rejected the analysis of perceptual experience into sensory elements, advocating instead a phenomenological description of immediate experience and proposing a theory of space perception not unrelated to Cartesian innate ideas, although stated in more useful and up-to-date physiological terms.

[3] *The aims and methods of structural psychology are very concisely described by A. P. Weiss in his article on " The Relation Between Structural and Behaviour Psychology." He writes : " By the term structural psychology is meant the type of investigation which assumes that there is an existential datum called mind or consciousness, within the totality of which ultimate differences may be discriminated which are given the names of (1) sensations, (2) images, (3) affections. These are usually regarded as the elements into which consciousness may be analyzed. The aim of the structural psychologist who accepts this analysis is to describe consciousness, in all its complexity, in terms of these three fundamental classes of consciousness. There is, of course, considerable difference of opinion between structuralists as to just how these classes are to be defined, and indeed, whether there are no more and no less than three elementary categories ... The structuralist aims to describe the structure of the mind or consciousness ... in terms of whatever elements he may have set up ... "*

The second was behaviourism. It too accepted the experimental method, but rejected introspection and thus the dualistic distinction between mind and body. Behaviour was considered the proper subject-matter for psychological study. There seemed no need to postulate the entity " mind " and then proceed to study its attributes and properties. It was simpler to work out the lawful relationships governing observable behaviour. The concept of consciousness no longer seemed as important or as necessary as it had heretofore. Of course behaviourism was not alone in pointing to this conclusion. Any system which ruled out consciousness from consideration of the mind could be termed " objective ; " and a whole range of more or less objective schools of thought existed before the behaviourists began to actively call attention to their point of view. One can list the positivistic philosophers, Loeb's tropistic school, the Russian reflexologists Sechenov, Bekhterev, and Pavlov, the work of the Wurzburg school in establishing the existence of determining tendencies which in part govern behaviour but are not available to introspection, and finally, the mechanistic aspects of Descartes' philosophy and that of his followers. Even Freud's investigations of unconscious motivations might deserve mention in this connection. Yet it should be pointed out that the data of introspection—that is, its verbal reports—could be retained and studied as examples of verbal behaviour. Moreover, this could be done without reference to any *a priori* theory of the supposed structure of the mind or the presumed mechanisms of perception underlying verbal behaviour. Language, therefore, could be examined in terms of a theory of meaning that did not presuppose words to be the vehicles of " thought."

THE INFLUENCE OF EXPERIMENTAL PSYCHOLOGY UPON LINGUISTICS

Behaviouristic psychology provided a more favourable intellectual milieu for modern linguistics than did the earlier school of structural psychology. This can be clearly seen after an examination of Leonard Bloomfield's *Introduction to the Study of Language,* which gives a thorough account of the state of linguistics in 1914.

The 1914 volume, based upon the doctrines of Wundt, opens with the assertion that " In the animal world every mental process is accompanied by a corresponding physical process. Some of these physical processes are *expressive movements.* Investigation has shown that the expressive movements are most directly co-ordinated with the emotional element that is present in every mental process. . . . In every experience there is present, beside the emotional elements (with which the expressive movements, we must suppose, are most directly connected), a series of perceptual impressions, whether of outer sensations or of imagery . . . " (pp. 1-3).

These statements express the Wundtian dualistic psychophysical parallelism as well as an elementalistic theory which regards every perceptual awareness of the external world as composed of—and analyzable into—sensationistic, imagistic, and emotional elements.

Language is viewed as intimately linked to the perceptual process in a relationship of mutual dependence. That is, the structure of language is primarily a consequence of the way we perceive reality, while at the same time, clear perception of the experiential elements depends in part on language. Without words we would be hard put to discriminate certain aspects of our environment.

This circular relationship arises in the following way. We, along with the animals, " experience the outside world not as a chaotic jumble of sensations, but as a system of complex recurrent units, as a world of objects " (p. 56). Every " total experience " is composed, then, of elemental compounds or " features." Moreover, our focus of attention shifts, first concentrating on one, and then upon some other aspect, or " dominant element " of the total experience. In Wundt's terminology, the total field of consciousness, or *Blickfeld,* is disposed into a number of potential loci of immediate and concentrated attention—these are the areas of potential *Blickpunkt.* All the elements are present in consciousness, but at any given moment they do not all receive equal attention. Certain dominant elements—colour, for example—may recur in different contexts: red is the colour of the cover of the *Literary History of England* sitting on my shelves, but also of the blood that flows from a gunshot wound. To dominant elements perceived as similar we attach words. In turn, the " association of experience types with fixed and instinctive sound-utterances represents an important step in mental progress. It makes possible attentive and connected thought " (p. 58). In other words, each dominant " element recalls those past experiences in which it has figured. But it does this obscurely, until language has given the experience a fixed and easily handled symbol with which we can keep it from slipping, as it were, through our fingers. Once language exists, however, the analysis of the experience into these elements is bound to develop " (p. 59).

Moreover, sentences relate their elements to one another in a " logical, or discursive relation " which corresponds to, and expresses the shifting of attention to a series of successive *Blickpunkte* so that " the analysis of a total experience always proceeds by single binary divisions into a part for the time being focused and a remainder. In the primary division of an experience into two parts, the one focused is called the *subject* and the one left for later attention the *predicate ;* the relation between them is called predication. If, after this first division, either subject or predicate or both receive further analysis, the elements in each case first singled out are again called subjects and the elements in relation to them, attributes " (p. 61).

However, " grammatical categories ... though always based on relations common in experience, universalize these, so that they must be formally expressed even where they are not actually present or where there is no occasion for focusing them, even though they are present. We must express actor and action in a sentence and tense in a verb even where they are not very vivid in the total experience " (p. 68).

Consequently, " our concepts of quality and action are purely linguistic " (p. 65). Therefore, " the explicit predication of quality or action is impossible for languages in

which every word expresses an object " (p. 111).[4] Thus language partly determines perceptual awareness of certain aspects of experience. Perhaps the most striking illustration of this influence results from the fact that " a number of experiences that are classed together in one speech community may not be classed together at all, or may form but a small part of a larger class, or may be in some other way distributed in another speech-community " (p. 84). In other words, our perception of similarities and dissimilarities is most directly governed by the linguistic categories available to us. Yet the reverse would seem to be true also.

It is evident from these few brief quotations that a somewhat ambiguous, but by no means naive theory of the relationship between language and perception was accepted by Bloomfield in 1914. Apparently he followed Wundt in viewing language as largely a resultant, but also partly a determinant of, the mechanism of perception. In many respects the 1914 edition anticipates the Whorfian hypothesis that " ... we dissect nature along lines laid down to us by our native language " (Carroll, 1953). But to this Bloomfield might have added that our characteristic way of dissecting nature also determines the structure that will be assumed by any highly elaborated language.

In English, such structural determination is reflected in the linguistic distinction between " independently re-current units of analysis," which are *words,* and the " formational elements," which are " imperfectly separable elements " of the linguistic system. For example, the word *suddenly* can be subdivided into *sudden* and *-ly.* Similarly, the words *flare, flash, flimmer, flicker,* and *flame* each contain the unit *fl-,* which acquires a vague connotation of motion (cf. p. 62 and p. 94). Both *-ly* and *fl-* are formational elements, since they cannot stand by themselves within a sentence, whereas *sudden,* on the other hand, could very well do so. Evidently, the formational elements include not only what we now call inflectional and derivational morphemes and their allomorphs, but also certain sequences without morphemic status.

This distinction, in turn, reflects the fact that there are two modes of analyzing experience: namely, the logical, or discursive mode discussed above, and associational analysis. The latter differs in one very important respect from the former. When the elements of experience are each " more or less vividly " separated within our minds as we perceive that experience, then the analysis has been *discursive* (p. 60). But it is known that " a frequently recurring arrangement of elements may become habitual and not require a vivid discursive analysis for its utterance " (p. 62). That is, the units that are sometimes perceived—upon careful introspection—to enter into various experiences, having been accorded corresponding grammatical categories, are on other occasions not noticed very sharply. Nonetheless, the grammatical categories become universalized " to furnish the mould for expressing all total experiences " (p. 68), and this takes place, it will be recalled, " even where [the perceived elements

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[4] *Earlier, in his review of Wundt's* Elemente der Volkerpsychologie, *Bloomfield had called attention to the dependence of " our concepts of quality, action, and relations " upon " a separately apperceived object of symbolic value which serves as dominant element in the complex forming the concept," adding that " this symbol object is, of course, the word."*

that gave rise to such categories] are not actually present or where there is no occasion for focusing them, even though they are present " (p. 69).

Hence it is that the passage from word to word within a sentence may not *always* correspond to the sequence of apperceptive attention. For example, in the phrase *A sleepy young linguist walked across the room,* we take the first four words as the subject, and the others as predicate, while within the subject *sleepy young,* and within the predicate, *across the room* are in clear attributive relationship, respectively, to *a linguist* and *walked.* Yet the groups *across the room* and *a linguist* are not usually perceived as discursive relations. That is, the units, *a, the* and *across,* are not sharply focused in consciousness as successive elements of the experience: they remain in the background of our awareness without being singled out—unless " we give the parts of the utterance much more than the usual degree of attention," in which case they become vividly focused by discursive analysis, even though such analysis might not originally have been the cause of their utterance (p. 61). As this example demonstrates, discursive analysis sometimes merges into, but ultimately differs from, the mode that Bloomfield calls *associational* analysis, for the latter expresses an habitual arrangement of the elements entering into a total experience: an arrangement or classification which is not in the forefront of our awareness of that particular experience, but nevertheless represents an ordering which we impose upon it in the act of perceiving.

In the example given, the implicit ordering involved matters of number: *a linguist* and *the room,* rather than *many linguists* and *several rooms.* It can be observed that units such as *a, the, many,* and *several* may be spotlighted by the attention, as it were, in an act of discursive analysis ; moreover, they can stand alone in the linguistic combinations called sentences: in both respects they differ from the formational elements, such as the pluralizing signal *-s,* which occur only as appendages to words. Consequently, a curious situation arises. Words may, and formational elements always, express an associational analysis of experience. But the former can be employed in discursive analysis whereas the latter never express any other that the associational aspects of experience, and therefore never attain more than partial independence within the linguistic system. Hence, even though this doctrine offers an explanation for the existence and role of inflectional affixes, it places them, along with words when used to express other than discursive analysis of experience, in uneasy partnership with units such as *fl-,* which have only the merest hint of associational signification arising from their occurrence in several words having vaguely similar meanings: *fl-* may call a misty emotional sensation of movement to our minds (because of its recurrence in, and association with, the series given above), but hardly anything more concrete, and certainly—Bloomfield would then have maintained—nothing that can be conceptually dealt with as an independent element descriptive of an aspect of experience ; *-s,* however, represents a more stabilized and well established associational awareness of the fact of plurality ; while a full-fledged word, such as *several,* enables us to discriminate at the level of discursive analysis—that is, of fully conscious conceptual awareness—the fact of plurality. *Fl-,* then, is the least, and *several* the most independent of the three, while *-s* is intermediate in this respect. Thus, to

phrase the matter in currently modish terminology, certain morphemes (including both roots and affixes) and some phonemes and phoneme clusters were thought of as standing almost in Hamlet's relation to Claudius: a little more than kin, and less than comfortably so. This was not an easy situation to live with, nor was it long tolerated by Bloomfield.

The first step towards a resolution of the problem followed hot on the heels of *An Introduction to the Study of Language*: in the same year that the larger work was issued from the press, Bloomfield published an article discussing in some detail the relationship between words and sentences. In it, he drew a more careful distinction between "an investigator's logical analysis after the fact and the actual psychic occurrence," stating that when this is done, it is "obvious and easily proved that in most of our speaking we are conscious of the whole sentence only, not of the words into which it may be divided." This is because associative analysis is "the primary and usual one," and discursive analysis "the more developed and rarer" (1914). In short, "even where there is a word-boundary, there is in most instances of utterance no apperceptive division." [5] This fact had been implicit in the viewpoint outlined in his *Introduction*, albeit its crucial methodological significance was not remarked in that book, and indeed, is only hinted at in the 1914 article. But considered in the light of later developments, such redoubled emphasis upon the associational (rather than discursive and elementalistic) nature of most experiences serves primarily to intensify the kinship between words and formational elements with respect to their role in the mental life, even while it remains no less evident that they behave very differently within the language used to express that mental life.[6] This bothersome disparity had to be harmonized somehow, or else linguists would be forced to rest content with simply noting the fact, and exclaiming, as Alice had in Wonderland, "Curiouser and curiouser ! "

The next step clarified matters enormously, but did not eliminate the difficulty. In 1916 Bloomfield devoted an article to exploring the relationship between subject and predicate. In it, he emphasized and made unmistakably explicit the distinction between *linguistic* and *logical* subjects and predicates, while at the same time

[5] *So Bloomfield summarized the earlier article in a later discussion of "Subject and Predicate" (1916).*

[6] *This increased stress upon the similar uses to which words and formational elements are put in most utterances did not imply a lessened awareness of their markedly different uses in those rarer statements expressing a discursive analysis of experience. For example, Bloomfield had stated in the* Introduction *(p. 62) that "words only, and scarcely ever formational elements, can be dealt with as conceptual units of general thinking." Then, in "Sentence and Word" he drew a very explicit distinction between formative elements and words, pointing out that "...both recur as the expression of a constant element of meaning, but the formative element is bound to certain positions with regard to the other elements, while the word may occur in all kinds of connections; and, above all: while both occur usually as associatively determined parts of a sentence, the word may be focused by the attention (clearly apperceived), while the formative element never rises to this explicit recognition."*

criticizing Wundt for failing to do so.[7] Acting upon a recognition that "the same distinctive word forms" may be used for both associational and discursive response to experience, he concluded that "if we wish to keep the terms 'linguistic subject' and 'linguistic predicate,' we must...define them not straightway as the linguistic expression of a logical [that is, expressing discursive analysis] subject and predicate, but rather as *linguistic elements which can be used in this function, but are used also in other utterances, as components of a habitual sentence-type*" (1916).

Moreover, in considering languages other than English in order to evolve a statement valid for any language, and starting from "Kretschmer's definition of the sentence as the linguistic expression of an affect—of a single rise and fall of the emotion prompting to speech," it becomes "clear that a single word can express only one separately apperceived element," and hence that we cannot interpret a Latin form such as *cantat* "as containing two such elements." To be sure, the form might be analysed after its utterance as an instance of discursive "judgement predicating the act of singing of a certain person, but the logical judgement is not present in the speaker's mind when the sentence-word *cantat* is spoken." That is, being felt as a single word, rather than two, "it contains no opportunity for an apperceptive (and hence for a logical) act of division." Therefore, we have "no right to speak of a linguistic subject and predicate" in this case (Bloomfield, 1916).

Finally, he notes in this article that an English word "such as *stones* contains two associatively joined elements; if we attentively separate these, we no longer use a single word, but speak of *several stones* or *some stones*, expressing the plurality by a separate word... the analysis into object and number in *stones* and into actor and action in *cantat* is never explicit; the word as a whole corresponds to the experience as a whole; this experience is associated with other partially unlike experiences, which are expressed by similar words, such as *stone, stony*... but the analysis involved in the existence and association of these parallel words is merely implicit and associative" (Bloomfield, 1916). This is a highly significant insight, for it amounts to an unblinking recognition that at least the majority of our apperceptions of the external world are far from analytic, that for the most part one perceives "the experience as a whole without breaking it up into an underlying element and a predication about it" (Bloomfield, 1916). This remarkable position, largely evolved within the framework of structural psychology, comes very close to discovering the Achilles' heel of elementalism: its rather too rigid insistence that all perceptual experience is composed of various discrete units.

[7] Bloomfield, "*Subject and Predicate.*" *He had advanced a similar criticism of Wundt in "Sentence and Word.*"

The primary source of that insight is not far to seek: Bloomfield had read, and in large measure accepted, William James' criticism of structural psychology.[8] James, in his chapters on the "stream of thought," had been one of the first, as he was one of the most persuasive, to complain that, in the German psychology "... the continuous flow of the mental stream is sacrificed, and in its place an atomism, a brickbat plan of construction, is preached, for the existence of which no good introspective grounds can be brought forward, and out of which presently grow all sorts of paradoxes and contradictions, the heritage of woe of students of the mind " (James, 1890). In this, he had anticipated by some twenty years the school of Gestalt psychology, whose doctrines grew out of a similar protest against the Wundtian analysis of consciousness into elements. Bloomfield, then, by 1916, clearly recognized, and attempted to grapple with, the difficulties inevitably arising from an application of structural psychology to linguistic issues. In doing so, he had been quick to appreciate the possible advantages of James' position, and had started to revise his own view of language phenomena in accord therewith. He might very well have continued in this direction, refining his theories apace with the developments in Gestalt psychology. But that proved unnecessary.

[8] In " *Subject and Predicate*," *Bloomfield has, in effect, put aside the elements postulated by structural psychology and attempted to examine afresh, with an eye to their implications for linguistics, the phenomenological facts of mental life. In stressing the need for that re-appraisal he refers the reader (p. 14, n.5) to William James' Principles of Psychology, I, 166f., 274f., and notes also (p. 15, n. 7) that the " process of sentence-utterance has been most vividly and exactly described by James in his Psychology, I, 260-263 ; the consequences for linguistic theory were not in this connection (nor, so far as I know, in any place) drawn by this great philosopher. See also Morris, T.A.P.A. XLVI, 103ff., esp. 110."*

However, Wundt's own cautions on this matter are also referred to, and it is important to bear this in mind, lest one be tempted to paint a distorted picture of the differences involved, which were largely on questions of emphasis in actual experimental procedures and introspective protocols ; both camps recognized, in theory, the need for avoiding an overly schematized discussion of the workings of the mind. But, in practice, the structuralists too often lost sight of that need. Professor Boring sums this up nicely in his History, remarking that " James' opposition to the elementism of Wundt and all the others appears most clearly in his discussion of the ' stream of thought.' There was no question in James' mind but that analysis is the necessary scientific method ; he believed, however, that the analytic description of mind should not be taken to mean that the real mind is a mere congeries of elements. Psychology had, he thought, lost the real whole in seeing only the elementary artifacts of its method. The main thing about consciousness is that it ' goes on ; ' it is a stream. For this same reason Wundt had argued that mind is process, but we have seen that the elementists did not always remember this principle, and that processes in their hands had a way of getting fixed. James had valid grounds for objection."

Morris, in his attempt to evolve " A Science of Style," mentions the need for understanding the mental processes that give rise to speech, referring to Wundt and calling attention to the work of Pick, who was then professor of neurology at Prague. Morris states that a thought is " expressed in parts, in a succession of sounds, but ... is at first whole and single and may be caught in that stage by introspection, as an unanalyzed and undifferentiated unit." However, the implications of this notion are not dwelt upon.

A far more direct pathway to the desired goal presented itself, for by the time the work of Wertheimer, Köhler, and Koffka had become generally known and influential in America, behaviourism had brought mechanism into vogue and supplanted the older structural psychology.[9] Cartesian dualism, and the elementalistic theory of perception along with it, had finally passed into the limbo of venerable, but no longer useful concepts. Linguists who took psychology seriously enough to follow and be influenced by its conceptual evolution were free, by the late nineteen-twenties, to fix their gaze firmly on the facts of verbal behaviour. There was no longer any necessity to mould what they discovered into conformity with a preconceived pattern—a pattern that, it will be recalled, had in part been shaped by the Mills as a result of their observations of grammatical categories.[10] Hence it was that Bloomfield, in 1933, could profess to have " learned, at any rate, what one of our masters suspected thirty year ago, namely, that we can pursue the study of language without reference to any one psychological doctrine, and that to do so safeguards our results and makes them more significant to workers in related fields." [11]

Behaviourism, in rejecting introspection, and thus the dualistic distinction between mind and body, made unnecessary the Gestalt resolution of the difficulties inherent in an elementalistic theory of perception, for the whole problem was thrown out of court—at least so far as the linguists were concerned. Having accepted behaviourism, there was no longer any reason for them to be professionally interested in the mechanism by which the " mind " receives its knowledge of the external world. The comparative rapidity with which linguistics [12] assumed this happy and inspiriting independence from the halting guidance of epistemology can be seen reflected in—

[9] *The Gestalt movement was started in 1912 by Wertheimer, but remained for the most part unknown in America until 1922, when Koffka published " Perception: an introduction to the Gestalt-theorie." Bloomfield may have read some of the earlier discussions in the German journals, but since he does not refer to them, and since wartime disruption of communications must have made it increasingly difficult, if not impossible, to secure German periodicals, it is reasonable to conclude that James, and then the behaviourists, provided the stimuli for all major changes apparent in Bloomfield's viewpoint between 1914 and 1922.*

[10] *This circular relationship had not gone unnoticed by Bloomfield, who, in his review of E. Hermann's Lautgesetz und Analogie, points out that " the great nineteenth century linguists tried to effect a synthesis by interpreting their methods in terms of Herbartian or Wundtian psychology, but the breakdown of those psychologies had made it plain that the interpretation was merely tautological, because the psychologic terms were at bottom derived from linguistic phenomena." See also his comments on general grammar in " On Recent Work in General Linguistics."*

[11] *Bloomfield, Language, p. vii. Of the behaviourists, Bloomfield drew his primary inspiration from A. P. Weiss, as has been remarked by B. Bloch (1949); by Carroll (1953); and by Bloomfield himself (1928).*

[12] *But not all students of language. Cf., for examples, Bloomfield's " Secondary and Tertiary Responses to Language " and Leo Spitzer's " Answer to Mr. Bloomfield." Professor Spitzer laments " . . . the nihilism of the behaviourists and anti-mentalists who do not know what the soul is."*

and indeed it was largely shaped by—the successive stands taken by Bloomfield on the issue.

He firmly asserted in 1914 that linguistic "phenomena themselves, without consideration of their mental significance are unintelligible, or rather, what is worse, liable to a post factum logical interpretation which substitutes for the actual state of things our reflections upon them." However, by 1922, it was announced that "... we are casting off our dependence on psychology, realizing that linguistics, like every other science, must study its subject matter in and for itself.... In other words, we must study people's habits of language—the way people talk—without bothering about the mental processes that we may conceive to underlie or accompany these habits." Much the same position was reiterated and amplified in articles appearing in 1924, 1927, 1932, and, after the publication of *Language*, 1936 and 1944, with the result that the Circean spell cast upon linguistics by structural psychology was finally broken, restoring subsequent studies in the field to their own proper form.

The most fundamental and far-reaching consequence of this liberation has been the now-familiar assumption that linguistic study must begin with the phonology of the language under consideration, and then proceed to describe the morphological and syntactic features in terms of structure within the system, rather than in terms of any causal interrelationships between such formal features of the language and the "mental life" of the speech community in question, or of the meanings particular features may have for individual members of the community: it being presupposed that "some speech utterances are alike as to form and meaning," with the meaning of a linguistic form understood as "the situation in which the speaker utters it and the response which it calls forth in the hearer" (Bloomfield, 1933).

Underlying that assumption, and necessary to it, are the concepts of the phoneme and the morpheme, both of which were far less tenable, if not impossible, within the framework of structural psychology. To be sure, Bloomfield had been able to recognize in 1914 that "each language has a limited sound-system, which, if only significant distinctions are counted and non-significant variations, whether automatic or merely casual, are ignored, is never very great" (*Introduction*, p. 55). However, there was no clear criterion for defining significant and non-significant distinctions between sound-units. This was because of the ambiguous role assigned to "formational elements." These latter might, or might not, have stable meanings ; some did and others didn't. That ambiguity, in turn, was a consequence of the elementalistic theory of perception which was accepted, and so became a determinant of recognizable linguistic categories. For *words* seemed to correspond very nicely to the perceptual elements, whereas pluralizing forms, for example, were not so easily thought of as being in one-to-one relationship with the elementalistic compounds available to analytic introspection. Hence it was difficult to recognize that affixes and words might be alike with respect to the *kinds* of meaning they conveyed, differing only in their behaviour within the linguistic system. But, once the theories of structural psychology had dropped out of sight, it was easier to accept what had become increasingly apparent: namely, that once the phonemes and morphemes of a

language had been established by noting behavioural differences in the informants responses to various linguistic stimuli, it was entirely possible to conduct the ensuing study of the morphological and syntactic features of that language without any further reference to kinds of meanings and modes of perceptual experience. Whatever varieties of " inner experience " might find expression on different occasions by any one particular feature of the linguistic system, it was considered sufficient to begin—and end—one's task with a description of the behaviour of that feature with respect to the rest of the linguistic system. The *Zeitgeist* had changed, and that change favoured the development of modern linguistic science.

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PHONEMIC SUBSTITUTIONS IN AN APHASIC PATIENT

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The paper gives an analysis of the phonemic substitutions occurring in the speech of an aphasic patient. The confusions are compared with those listed in published material referring to the development of speech in children.

It has been held by various writers on the subject of aphasia that changes in the speech of an adult aphasic bear some relation to the developments in the speech of a child when he is learning to talk. This is said to be particularly the case at the phonetic and phonemic level of speech: the sounds which the child acquires last will be the first to be affected in aphasic disturbances and, further, will be the last to re-appear in cases where the aphasic patient recovers his speech. Thus Alajouanine (1956) says: " It is our impression that there are strong analogies between the pathological phonetic alterations (in aphasia) and the first manifestations of infantile language. . . . Numerous changes which can be observed during different stages of recovery in our patients are also found in the normal phonetic progress of a child, i.e. dissimilation, assimilation, metathesis, elision, etc., to use the terminology of phonetics ".

Other authors, including Critchley (1952), have held this theory to be unsound for a variety of reasons. The main purpose of the present paper is not so much to advance arguments on either side but to show that systematic observations are needed as evidence in this matter and to suggest one form that these observations might take. At the same time it must be noted that any theory about the relation of the development of speech to its deterioration in aphasia obviously cannot be confined to the phonemic level. Speech involves activity at several different levels—the phonemic, morphemic, word and sentence levels—which are interdependent and if in fact the disintegration of speech in any sense mirrors its development, then the effects must be discernible at all these levels.

One of the chief difficulties of collecting evidence on this point, as Critchley has pointed out, lies precisely in the fact that the various levels of speech are interdependent, and that speech activity itself is linked with other forms of general behaviour as well

as behaviour specifically connected with language. It is comparatively rarely that we find clear-cut examples of deterioration in the phonemic pattern of speech, for example, without the effect's being masked by many other factors. One such case is reported in this paper ; it is a single case and cannot do more than contribute towards the evidence, but it provides an opportunity of showing that systematic observations can be obtained.

CASE HISTORY

The patient was admitted to hospital towards the end of 1958, aged 74 years. He gave no history of serious illness either as a child or adult ; he had been in an Army hospital forty years before with war injuries, but had not been in hospital since. He first began to have difficulty with his speech in the summer of 1957. The difficulties increased slowly until about three weeks before his admission to hospital and at that time there was a rapid and marked deterioration during a period of three days. Since then, there has been no major change in his condition.

The patient's basic difficulty is in expressing himself. His understanding is not impaired and his mental grasp appears to his family to be as good as ever. His speech is slow and hesitant and he frequently has great difficulty in finding the word he needs. Often this causes difficulty in beginning sentences, and sometimes will hold him up in the middle of a sentence. He seldom uses a wrong word and if given plenty of time can often find the right one. If the right word is supplied, he quickly uses it in the proper way. He names objects surprisingly well and when he fails to do so he can easily select the right word from a list supplied to him. He has a marked impairment in writing, either spontaneously or at dictation, but has no difficulty in reading.

When he is held up in speech, he most frequently repeats some sound which may or may not be the beginning of the word he needs. He does not substitute a wrong word, usually, or use any form of jargon. He finds reading aloud easier than spontaneous speech ; when he reads aloud, he mispronounces many words and hesitates a good deal, but often ends by finding the right word.

Briefly, then, here is a patient whose major difficulty is in the transmission side of speech, and in particular in forming the right phonemic sequences. In this case, it should be possible to see fairly clearly the disturbances in the phonemic patterns.

COLLECTING THE DATA

A study of the patient's speech behaviour has been made from a tape recording of his speech in various situations. Samples of his spontaneous speech were recorded, but it was impossible to obtain any very lengthy series of utterances since the patient is well aware of his difficulty and does not carry on a conversation of any length even with his family. Since he has no difficulty in reading, that is in the visual recognition

of print, it was possible to collect a considerable body of material by asking him to read aloud two types of stereotyped text ; the first were sentence articulation tests and the second, word articulation tests of the type used in clinics for the deaf. The sentences were of the very simplest construction and vocabulary, such as " The woman sat in the park ". The word lists consisted of consonant-vowel-consonant mono-syllabic English words. The distribution of phonemes in both these types of material is known and both are so simple from the semantic and syntactic point of view that they might be expected to throw into relief the patient's difficulties in phoneme selection.

The word lists contained only CVC words, that is words without consonant clusters. The patient found words with consonant clusters particularly difficult and had other types of list been used, the proportion of errors might well have been higher. The figures given in a later section for phonemic confusions are based on his reading of ten word lists, containing in all 1000 English phonemes, with a distribution that faithfully reflects their occurrences in current English speech.

GENERAL FEATURES OF THE PATIENT'S SPEECH

The features noted in the clinical examination are clearly seen in the recording of the patient's speech. In spontaneous speech, there are many hesitations, some caused by particular sounds. Sometimes the patient had to give up the attempt to make some specific remark because of his difficulty in forming a particular word. In reading aloud this also happened, but rather less frequently. There were none the less some sentences and also some isolated words that he was unable to produce at all, and many more that he uttered only after considerable hesitation.

The main concern of this paper is with the phonemic confusions occurring in the patient's speech, and these are dealt with in detail in a later section. There are two features, however, which should be noted first as they are concerned with other levels of speech organization. First there was some degree of perseveration apparent in his reading aloud. He was asked to read in succession word lists that were identified by a number ; he was asked to say, for example, " List four " and then to read the first word on the list. In several cases this gave rise to perseveration. Instead of reading the first word in list four, he simply repeated " four " and then went on to the second word in the list. Peseveration was also apparent sometimes at the phonemic level. In reading the sequence of words: *wood, kick, wear, feet,* he read correctly the first word, *wood,* and then retained initial /w/ in the next, for which he said /wik/. The effect was re-inforced because the following word happened to begin with /w/. He pronounced this correctly and then followed it with /wi:t/ instead of /fi:t/. After saying " List six ", he pronounced the first word of that list /suk/ instead of /kuk/ and in another case pronounced the word *fun* as /rʌn/ when it followed the word *rook.*

Errors arising in this way are of a slightly different kind from other phonemic substitutions for which it was impossible to see any specific reason in the immediate

SOUND SUBSTITUTED

SOUND NORMAL	i:	i	e	a	a:	o	o:	u	u:	ʌ	ə:	ei	ou	ai	au	oi	iə	eə	Ɔ
i:	75	15																	10
i		83					1	1		3						1	6		5
e	5	5	77	3			3												7
a		5		80						10						5			
a:					90				10										
o						80				10									10
o:	10						80						10						
u								80		10	10								
u:									100										
ʌ										100									
ə:		10									90								
ei		5										75	5	10					5
ou													90		5				5
ai	7				3									83	3	3			
au							10								90				
oi																100			
iə		20									10					10	60		
eə																		100	

Fig. 1(a).

context. The number of these in the material examined was low, however, and for this reason they have been retained in the results.

In a few instances there were obvious errors at the morphemic level, as distinct from the word level, usually consisting in the addition of a morpheme. Thus, *move* was read as *moved*, *pass* as *past*, *year* as *years*. There was also one case in which the patient said *young* for *younger* and another in which he used the form /tukt/ instead of *took*. One or two errors at the phonemic level were therefore contributed in this way.

PHONEMIC SUBSTITUTIONS

The patient's reading of the word-lists was analysed in order to list the errors which occurred. The patient was able to read many of the words correctly without hesitation ; in many other cases he hesitated and began to produce a sound which was sometimes the required one and sometimes another and after a second or two of hesitation would produce the right word. In all such cases, the response was noted as correct, and no error was entered in the list of confusions. Frequently, however, the patient would give the wrong phonemic sequence and would be apparently unaware of this fact. These phonemic confusions form the basis for the confusion matrices given in

SOUND SUBSTITUTED

NORMAL SOUND

	p	b	t	d	k	g	tʃ	dʒ	f	v	θ	ð	s	z	ʃ	h	m	n	ŋ	l	r	j	w	Ω
p	**70**		20		5												5							
b		**75**	5														5							15
t	3		**80**		6						1		1				4	1						4
d		2	3	**57**	5	3	2	2	2			3					5	7		3	2			4
k			3		**85**								3				3	5		1				
g					40	**50**	10																	
tʃ							**100**																	
dʒ			10					**70**					10											10
f		5							**80**											5	5			5
v			5	5					20	**65**														5
θ									10		**70**	20												
ð											5	**90**								5				
s						2					2	2	**87**	2			2	2						1
z													20	**80**										
ʃ															**100**									
h				10									10			**70**	10							
m				3									3	3			**80**		3	3				5
n		4															4	**84**		1	1			6
ŋ																			**90**					10
l		5											3							**82**				10
r				3									3					10			**77**		3	4
j																	10					**90**		
w																	3	3		3			**87**	4

(b)

Fig. 1. (a) Vowel substitutions and (b) consonant substitutions in the patient's speech. Underlined figures show how frequently a sound was correctly articulated, expressed as a percentage of the sound's total occurrences. Other figures show the percentage of confusions ; the last column shows how often the sound was omitted altogether.

Figure 1. It has been said that the material comprised 1000 phonemes, having a normal distribution for current English. In the confusion matrix, the figures show with respect to each phoneme the percentage of its occurrences on which it was correctly produced by the patient or replaced by another phoneme. Each row in the matrix refers to the phoneme occurring in the material to be read, and each column refers to the sounds actually spoken by the patient. Thus the first row shows that where /p/ occurred in the text, the patient used /p/ in 70% of the cases, replaced it by /t/ in 20%, by /k/ in 5% and by /m/ in 5% of occurrences. The last column in the matrix denotes the omission of the sound altogether ; thus /b/ was omitted in 15% of its occurrences in the text.

ANALYSIS OF PHONETIC CONFUSIONS

The patient made errors in 19·2% of all the phonemes that made up the word lists. The consonants accounted for rather more errors than the vowels, though the difference was not as great as might be expected ; 16% of all the vowels gave rise to errors, and 21% of all the consonants.

Vowels and consonants are already separated in the matrix ; there are in fact no cases of a vowel being replaced by a consonant or a consonant by a vowel. Interesting facts appear if we group together in various ways the errors which the patient makes.

Place of articulation

There were 137 consonant errors in all, and of these 80 involved an error in the place of articulation ; these included a large group of errors in /t/ and /d/ which were frequently replaced by velar articulations.

Manner of articulation

Mistakes in the manner of articulating a consonant were not quite so frequent ; the total number was 62 and here again /t/ and /d/ accounted for quite a proportion of the errors. There were also a number of confusions between plosives and nasal consonants.

Voiced/voiceless confusions

One of the more remarkable features of the patient's speech was the frequency with which a voiced consonant was replaced by a voiceless, and vice versa. This is an error that is met with very little in other types of speech and hence its occurrence here is all the more striking. There were 49 cases in the word lists where this error occurred. Among the plosives there was a strong tendency for the voiced plosives to be replaced by the voiceless ; practically all the errors in /g/ consisted in replacing it by /k/. The most interesting feature of this type of error was that the phonemic substitution was complete and hence involved a re-arrangement of the time scheme of a whole word, particularly when the consonant followed a vowel. The patient said /mʌk/ for *mug*, for example, with the appropriate vowel length for its voiceless consonant and yet was apparently unaware that he had made any substitution. Much more is involved here than a failure to make the larynx work when it is required ; the whole organization of the syllable has to be changed, including the vowel length and the articulation of the final plosive, which in /k/ has a fortis articulation and a certain degree of aspiration. The fact that the patient did not even notice most of these errors points to a genuine error at the level of the phonemic organization of speech where the wrong unit seems to have been selected. It was not that at the level of articulation he merely made a poor attempt at the correct phoneme.

In addition to these three types of error there were all the cases in both the spontaneous speech and in reading where the patient hesitated before finally producing the required sound. Four consonants gave the greatest difficulty in this respect ; they were /t, v, s, z/.

COMPARISON WITH CHILDREN'S SPEECH

The figures given in this paper refer to one sample of the speech of a single aphasic patient. They clearly cannot form the basis for any extensive comparison with the development of speech in children. Here again the only purpose is to show the lines along which such a comparison might be made.

First, with regard to the validity of the sample of the patient's speech, we should need to compare recordings taken on different occasions in order to discover whether the phonemic substitutions were very variable or were consistent on different occasions. At present only a small amount of material has been repeated but the indications are that the errors are surprisingly consistent. In the same word list recorded by the patient at an interval of one month, the number of errors was the same on the two occasions and the most striking substitutions were reproduced exactly ; these were such errors as /fain/ for *vine,* /fev/ for *fed* and /mʌk/ for *mug.* There were differences between the two readings but these involved only the most infrequent type of error. The errors we have noted in the patient's speech seem therefore to be systematic and not by any means random.

In order to compare such a sample with children's speech we need similar information about the substitutions made by young children. A great many such substitutions are due to difficulties at the phonetic level, that is to say they represent the child's attempt to produce a sound which he is as yet unable to form in the adult way. This in itself tells us something about the development of speech but makes comparison with the speech of an aphasic patient rather difficult except in cases where we find phonetic as distinct from phonemic difficulties in the latter. However, an extensive survey of children's speech among a large sample of the population would serve to show which sounds give the most difficulty or are the last to be acquired and which substitutions persist in the case of children with defects of articulation. The published literature contains some information of this nature. One of the most complete accounts is given by Morley (1957) who made a careful survey of the speech of a large sample of English children and gives results detailed enough to provide a basis for comparison.

It must be remembered that this information deals, not with the substitutions occurring in the speech of one speaker, but with the incidence of substitutions among a large group of children. The group numbered 162, and the figures given here refer to the children's speech at the age of 3 years 9 months. They were children who were noticed to have some defects of articulation still at that age and they may be taken as affording a reasonable criterion of the difficulty with which the various English sounds are acquired by English children. If a large proportion of children experience difficulty with a particular sound we may conclude that it is more difficult to acquire than another with which only a small proportion of children find difficulty. A summary of this information is contained in the confusion matrix of Figure 2, which gives consonants only. The rows of the matrix refer to the sound found in normal speech ; the columns give the sound habitually substituted for it by the children, and

SOUND SUBSTITUTED

NORMAL SOUND	p	b	t	d	k	g	ʧ	ʤ	f	v	θ	ð	s	z	ʃ	h	m	n	ŋ	l	r	j	w	Ø
p	**98**	2																						
b		**98**		2																				
t			**93**		4								2											1
d				**98**		2																		
k			38		**59**								2											1
g				21		**78**																		1
ʧ			16	1			**75**						2											4
ʤ				19		1		**68**						7										4
f	7	10							**72**		2		4		4							1		
v		6								**93**														
θ	2	10							46		**23**		7		3									7
ð		1		6						4		**84**	1							1		1		2
s		22								2			**64**	4	1									5
ʃ		12		1		3							19		**59**	2					1	1		2
h																**100**								
m																	**100**							
n																		**100**						
ŋ																			**100**					
l																				**91**	3	4		2
r				1																9	48	6	33	2
j																					7	**87**	2	4
w															1								**96**	2

Fig. 2. Consonant confusions in the speech of a group of 162 children. Figures denote a percentage of this number.

the last column shows how frequently the sound was omitted altogether. The numbers show the proportion of children who make the substitution ; the proportion is expressed as a percentage in order to make it possible to compare this matrix with that given in Figure 1 for the aphasic patient.

It is clear that there are major differences in the two distributions though it is difficult to evolve a meaningful measure of the difference. A gross comparison can be made by referring to Table 1 where the sounds are ranked in the order of difficulty for the children, that is according to the percentage of children who replaced them by other sounds. The incidence of error for each sound in the speech of the patient is given in the table. The plosive group which gave considerable difficulty to the patient are relatively easy for the children, except for /k/ and in some measure /g/. Among the children, errors in the place of articulation far outnumbered other kinds of

TABLE 1

| | Percentage error | |
Sound	Children's speech	Patient's speech
θ	77	30
r	52	23
k	41	15
ʃ	41	0
s	36	13
dʒ	32	30
f	28	20
tʃ	25	0
g	22	50
ð	16	10
j	13	10
l	9	18
v	7	35
t	7	20
w	4	13
d	2	43
p	2	30
b	2	25
h	0	30
m	0	20
n	0	16
ŋ	0	10

A comparison of the consonant errors occurring in
the group of children and in the patient's speech.

error and it is interesting to note that the voiced/voiceless confusion which was quite common in the aphasic is practically unknown in the children's speech. When it does occur it is generally the result of the child's substituting /j/ or /w/ for quite a variety of sounds, some of which may be voiceless ones ; there is no case of the replacing of a sound by its voiced or voiceless counterpart as there was in the patient's speech.

CONCLUSIONS

An attempt has been made to show that a systematic account of the phonemic level of speech in aphasic and dysphasic patients may be possible and also useful. The complex nature of most aphasic disturbances and the variability of a great deal of dysphasic speech make the task very difficult but where the patient's disability is

not very extensive such observations can be made. The evidence of the case reported here tends to contradict the idea that the degeneration of speech in aphasia mirrors its development in childhood. There appears to be little in common between the patient's speech and the features of child speech as they have been reported.

The patient referred to is a patient of Dr. Macdonald Critchley. The author wishes to thank Dr. Critchley both for suggesting the analysis of the patient's speech and for his help in investigating the case.

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SOME EFFECTS OF WORD LEARNING IN IMBECILES

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Two experiments concerned with generalisation between words in imbecile children were carried out. The first of these compared the effects of learning three word lists, differently connected with a common list of test words, for amount and direction of transfer on the second task. It was found that while no difference in rates of learning occurred in the control group, negative transfer effects were evident with subjects who learned two lists of near synonyms. A group who learned two lists of near homonyms needed fewer trials on the second task. Transfer was found to be independent of I.Q. level. It was concluded that learning sets, leading to generalisation along semantic as well as physical dimensions, could be built up in imbeciles. In the second experiment word associations to the words in the common test list were related to previous learning experience. Word associations were shown to fall into two main classes of either meaningfully related or unconnected responses. Only a small number of " clang " associations were given. While such tendencies were not significantly altered by previous training in either neutral or sound connected word learning, learning of near synonyms significantly strengthened the tendency to give meaningfully connected word associations.

Introduction

Russian psychologists, notably A. R. Luria (1956), have recently drawn attention to the role language plays in helping the developing child to govern his own behaviour. Investigating the specific nature of the difficulties which the severely subnormal have in carrying out mental operations, Luria showed that connecting links between behaviour and its verbal formulation, as well as connections between meaningfully related words, seem to be insufficiently developed in imbeciles. The present investigation is concerned with the second part of this theory, the alleged lack of association between semantically related symbols in subnormal children of imbecile grade.

The recognition of meaningful similarity of verbal and other symbols depends on learning. Therefore semantic generalisation presupposes a formation of conditioned response connections which has been established prior to the experimental situation. Evidence obtained from conditioning normal subjects seems to indicate that response generalisation occurs to meaningfully related symbols and signs. Razran (1939) found that more generalisation occurred to semantically similar words (for example, " style " to " fashion ") than to phonetically similar words (for example, " style " to " stile "). Riess (1946) related conditions of verbal generalisation to age and found that meaningful

or semantic generalisation increases with development, whereas phonic generalisation decreases. Cofer and Foley (1942) varied the character of interpolated word lists to test the effect on recall of previously learned words with adults. Although results were not clearcut the largest number of words recalled were those following interpolated homonym lists, the second largest those following synonyms, and the least those recalled following an interpolated control list.

Measuring orientating reflexes towards word stimuli by recording plethysmographic reactions, Luria found that the severely subnormal orientated towards systems of acoustically similar word groups, rather than towards conceptually related words. The Russian investigators were concerned with conditioned reflex responses. In this experiment we are primarily interested in the development of learning sets which might influence specific connections between words. In previous work we have confirmed Russian findings of deficient connections between verbal and motor behaviour in imbecile children. We also found that once bonds between directive principles and behaviour were established, these tended to be perseverative and stable, and readily transferred to related tasks. In order to delineate the characteristics of the learning process in the severely backward more precisely, it seemed necessary to investigate whether learning sets would be operative with symbolic material such as words. Our first experiment therefore tested whether physical similarity of two word lists, meaningfully similar words and unconnected word lists would have differential effects on rates of learning.

EXPERIMENT I

Subjects

Subjects were 30 institutionalised imbecile children with mean I.Q.: 40, range: 30 - 50, and mean ages: 12 years, range 9 - 16 years. They were selected according to whether they attended the occupation centre school, had some intelligible speech and no gross psychotic, motor or sensory disturbances.

Material

This consisted of a list of six christian names used for matching purposes, three different training lists, and one common test list. While no obvious relationship existed between the neutral list (N) and the test list (T), list (M) contained words of similar meaning to those in the common test list, and (S) was related by sound similarity to the test list. The words used were:

(Matching)	(N)	(M)	(S)	(T)
Peter	Child	Food	Heel	Meal
John	School	Frock	Mess	Dress
Mary	Window	Trousers	Ants	Pants
Kenneth	Star	City	Brown	Town
Ann	Cat	Lorry	Duck	Truck
Michael	Ball	Street	Boat	Road

Procedure

The subjects had to learn to repeat word lists, each containing six words, by the method of serial anticipation. The experimenter spoke the first three words of a given list with one second intervals between words. The subject was then asked to repeat them. If he failed to recall the three words correctly, in the correct order, they were again spoken by the experimenter. When one correct repetition occurred, the full list of six words was presented. After each repetition trial by the subject, the list was re-presented by the experimenter until four consecutive faultless repetitions were given. Each correct repetition was rewarded by a sweet and by the experimenter saying " Good ". On each incorrect attempt the experimenter said: " No, I will tell you the words again ".

The subjects were first tested on the list of christian names. They were ranked according to the number of trials needed to learn to criterion. Matched triplets were formed, one of each of whom was alloted at random to one of three groups. Another trial session followed in which one of the three training lists and the common test material had to be learned. The training list for each group differed in its relationship to the test list (T), which was the same for all subjects. The control group learned two word lists which were not connected (N + T). The second group was presented with two lists of meaningful similarity so that the relationship between them was semantic (M + T), while the remaining subjects learned two similar sounding lists of words (S + T). The two word lists followed each other after a time interval of five minutes, during which subject and experimenter talked about matters unrelated to the experiment.

Results

Groups were matched for I.Q. Subjects' scores, in terms of number of trials to learn to criteria are set out in Table 1.

It will be seen that the training and test scores for the N group are the same, but that for the other two groups, M and S, they differ. An analysis of variance was carried out based on the scores presented in Table 1. Neither main effect was significant, showing that the mean scores were statistically identical. The interaction between groups and training methods or treatments was next tested. As the residual included *between people within groups* variance, the latter term was subtracted and the remaining error term used as a denominator in obtaining the F ratio for the

TABLE 1

	No connection		Meaningful connection		Sound connection	
	N	T	M	T	S	T
1.	5	5	6	8	6	4
2.	9	9	3	3	9	5
3.	5	5	4	10	9	7
4.	11	13	11	15	14	9
5.	7	7	16	24	7	7
6.	6	6	9	11	10	9
7.	16	16	18	25	18	11
8.	14	14	10	14	26	19
9.	21	21	16	20	20	20
10.	12	13	11	13	14	15
$\overline{X}$	10·6	10·9	10·4	14·3	13·3	10·6

Number of trials to learn to criterion in Experiment I.

interaction term. This was then found to be significant ($F = 20\cdot68$, ds.f $= 27/26$, $P = 0\cdot001$). The same term was used to test the variance between people within groups. This was also found to be significant ($F = 24\cdot0$, ds.f $= 28/26$, $P = 0\cdot001$).

In this experiment this clearly establishes the statistical significance of the difference between the effect of treatment on final test results. This fact is obscured in the raw scores but is made obvious at once in Table 2 where the difference scores between trials to learn test material and number of trials to learn initial training material are set out. It can be seen that whereas the changes in the M group were nearly all negative and the changes in the S group nearly all positive, practically no changes in either direction were present in the N group. A *t* test carried out between the M and S group difference scores showed them to differ significantly at the 0·001 level of confidence ($t = 5\cdot43$, $n = 18$). Because the mean difference score of the N group was near zero it was necessary to test the significance of the differences from zero of the mean difference from the M and S groups in order to establish that each of them in turn differed from it. In both cases *t* was significant ($t = 4\cdot3$ and $2\cdot6$, $P = 0\cdot01$ and $0\cdot02$, respectively, $n = 9$). It could be argued that an analysis of variance should not have been carried out on the data in Table 1 because the difference scores between training and test trials for the N group are nearly all zero. However, as the three *t*s are highly significant the analysis was presented as a matter

TABLE 2

Control Group	Semantic Group	Clang Group
N - T	M - T	S - T
0	− 2	+ 2
0	0	+ 4
0	− 6	+ 2
− 2	− 4	+ 5
0	− 8	0
0	− 2	+ 1
0	− 7	+ 7
0	− 4	+ 7
0	− 4	0
− 1	− 2	− 1
X̄ − 0·3	− 3·9	+ 2·7

Differences in number of trials between two word lists in Experiment I.

of some statistical interest. Whether this method is followed or *t* tests are used does not change the interpretation of the data.[1]

The groups differed not only in amount and direction of change, but also in the qualitative nature of the effects of training on test words. While failure of word repetition in the case of the N + T and S + T groups was characterised by omission of words, interference leading to incorrect responses was evident in the M + T group. In this group subjects frequently substituted words which were first learned for the appropriate meaningfully similar ones in the subsequent task. Thus, while first having had to learn " street " and subsequently " road ", the child often said " street " in both instances. Such negative transfer occurred at a mean of 2·0 instances during the learning of the test list, while none was evident with any of the other groups. Occasionally a subject would become aware of such an error and correct himself.

There was a statistically non-significant mean I.Q. difference of six points between the 15 subjects who needed fewer and the 15 who needed more trials to learn the original matching task. On the other hand the amount of effect which N, M and S lists respectively had on T did not differ within each group between faster and slower learners. It seemed that while I.Q. affected rate of learning it did not influence the amount of transfer occurring in this experiment. A set, once established, was as effective in those with higher as well as those with lower I.Q., and with the relatively fast learners as well as with the slower ones.

[1] *We are indebted to Dr. A. E. Maxwell for advice concerning the statistical issues arising in connection with this experiment.*

Discussion

Transfer effects on word learning tasks were observed in this experiment, and were found to be independent of either I.Q. differences or original rates of learning. This might have some importance for learning in imbecile children.

As far as the facilitating effect of word learning on subsequent learning of homonyms is concerned, the results of the present experiment are in accordance with much of the previous work mentioned earlier. In the case of normal young children, Riess (op. cit.) and in the case of subnormal, Burt (1950) and Luria (1956) have all shown that such clang connections help association between word stimuli. This kind of word learning is little concerned with the elective functions of speech, but represents a form of motor activity in which practice helps similar subsequent learning. Such physical similarity of the material is absent in the control group, and therefore learning of one word list has no effect on learning the second one.

The effect of word learning on the rate of learning of subsequent meaningfully similar words suggests two conclusions. Firstly, in contrast to Luria's findings on conditioning, some generalisation along semantic dimensions seems to take place in this word learning experiment, and secondly such generalisation becomes effective in the form of interference. As Osgood (1948) has shown, comparative results from studies with normals show similar trends, although a tendency to perseverate is probably more marked in imbeciles. What should be noted is that regardless of the direction of change the effect of a semantic connection between words is apparent. It seemed desirable to test the extent to which such connections were stable and lasting. After a time interval of three months a second experiment was therefore carried out, which aimed to test if word association, given to the previously learned common test list, would be related to the specific learning experiences of the groups.

EXPERIMENT II

Introduction

The association experiment, which usually serves to discover individual differences, especially of an abnormal sort, was used in the present study to determine whether previous learning would influence subsequent associations. It must be remembered that verbal association studies are distinctly experiments with words. Dorcus (1932) and Karwoski, Gramlich and Arnott (1944) have shown that verbal responses to objects or pictures differ from responses to the names of such objects. In this study however our interest was limited to the kind of connections which imbeciles form between symbols such as words.

Using the Kent-Rosanoff word list, and comparing associations from 9 - 12 year-old children obtained by Woodrow and Lovell, and associations noted by the same workers and by O'Connor for adults, as quoted by Woodworth (1947), some interesting qualitative differences are apparent. Children tend to respond to the stimulus word

with another which is descriptive or explanatory whereas the adult tends to jump to related, parallel ideas suggested by common word forms. Children consequently give few " opposite " or " co-ordinate " word associations. In the defective, as Burt (op. cit.) has shown, this lack of mobility is enhanced and perseverative responses, repetition of the stimulus word, and clang associations predominate. However, Woodworth (op. cit.) states that Otis found repetition of the stimulus word a common response in 4 - 5 year-olds, defining sentence response in 4 - 7 year-olds and normal single word responses only common in children from 6 years upwards.

As the purpose of the present experiment was to relate association to previous learning experience, the response words were classified in the same manner as the connections between the original word list, i.e. meaningful connections (m), sound connections (s) and no connection (n). Repetitions of stimulus words were scored together with sound connected associations.

Procedure

The following instruction was given to each child, " Remember that you learned some words last time ? This time I am going to tell you some of them again. Whenever I say a word I want you to say another. You can say any word you like." Each of the six words from the common test list was then presented and the response word noted. In addition ten children who had not participated in the first experiment were given the word stimuli and were asked to respond with the first word which occurred to them. When the response was the repetition of the stimulus word, this was given again at the end of the list and the second response, whether repetitive or otherwise, was accepted. Responses were scored independently by both of us. One of the investigators had no knowledge of the particular previous training experience of the subjects and in case of disagreement his rating was accepted.

Responses were rated as neutral (n) if no connection between stimulus and response word was easily apparent (for instance, " hand " in response to " dress ", and " window " to " pants "). All words which were either a description of the stimulus word, or nominated an activity appropriate to it, or were words which stood in a subordinate, superordinate or similar relationship, or were near synonyms, were rated as meaningful (m). For instance, " eat ", " dinner " and " potatoes " to " meal " were scored in this way. Associations which were apparently prompted by a similar sounding word were rated as (s) responses, " drug " to " truck " for instance, but also " pencil " to " pants ".

Results

The frequencies and percentages with which each type of association occurred in each group are given in Table 3.

The null hypothesis that no relationship between type of learning and type of association exists can be rejected at the 0·001 level of confidence ($\chi^2 = 43·7$). This difference, however, is mainly due to the response distribution in the M (meaningful

TABLE 3

Groups	Responses				
	(n)	(m)	(s)	Total	%
N	33 = 55%	20 = 33%	7 = 12%	60	100
M	9 = 15%	51 = 85%	0 = 0%	60	100
S	22 = 37%	25 = 41%	13 = 22%	60	100
C	26 = 43%	29 = 48%	5 = 8%	60	100
Total	90	125	25		240

Distribution of word association types in Experiment II.

training) group. χ^2 between the N and S groups alone is non-significant. There is also no significant difference in response distribution between the N and S groups and the subjects in the new additional control group (C), who had received no previous training. In view of the interdependence of the frequencies in the cells, χ^2 is not strictly appropriate but as it is highly significant it may be accepted as a verification of the obvious trend of the results. As can be seen from Table 3, (s) responses were given relatively rarely by all subjects. This is surprising in the light of Luria's as well as Burt's (op. cit.) findings, that orientation toward sound similarity and "clang associations" predominate in subnormals. On the other hand the relative infrequency of sound related words in the language would not lead one to expect this type of response to occur often.

The M group gave 85 per cent of all its associations in meaningful connection with the stimulus word, while the N group gave 55 per cent unrelated associations. It is interesting that meaningful associations also tended to predominate in the S and C groups as well as in the M group (41 per cent and 48 per cent) and remained relatively high in the N group (33 per cent).

Discussion

It seems from this study that word associations of imbeciles fall into two main classes. They are either semantically connected with the stimulus word or show a lack of any obvious relation to it. A relatively small percentage of associations consisted of repetition of the stimulus word or words prompted by sound similarity. Luria measured conditioned reflex responses to given word stimuli which were either phonically or semantically related to the conditioned word stimulus. In our experiment the children had to select verbal responses to stimulus words. In such a situation, in contrast to Luria's findings, there is at least some tendency to give

meaningfully connected associations to words. The general conclusion drawn from the Russian experiment that meaningful systems of words are not easily established in imbeciles, might consequently not be fully justified. Of course the possibility should not be ruled out that some of the apparently " nèutral " responses had some meaningful personal connection with the stimulus word for the subject. However, qualitative observations do not make this a very probable interpretation. These rather suggested complete randomness of associations rated as neutral, prompted for instance by such features as enumeration of things in the room.

Learning of unconnected or sound connected words prior to the association test seems to enhance either of these association trends, but the effect is statistically insignificant. Training in semantically connected word learning on the other hand seems to lead to an effective " set " which significantly strengthens a pre-experimental tendency. The results seem to confirm previous work, that once the nature of stimulus and response connection is grasped the resulting set is extremely stable and tends to persist. Both the negative transfer effect in the first experiment and the high frequency of (m) response in the second are in line with such an interpretation. Such a finding is relevant for the learning of backward children.

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A QUANTITATIVE TYPOLOGY OF LANGUAGES

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This paper discusses the necessity for a quantitative investigation of qualitative linguistic facts, mentions several conceptions of typology and deals in detail with the classification into vocalic and consonantal languages. The main task of the paper is to attempt to classify languages according to the manner in which they exploit particular kinds of consonants. The exploitation of the sounds of a language is given by the relation of the sounds of the inventory to their relative occurrence in texts. Having examined 23 languages, the author distinguishes, on the basis of the distribution of consonant articulations, three types of language according to the manner of articulation and similarly three types of language according to the place of articulation.

The question of establishing the classification of languages on the basis of a quantitative treatment of linguistic phenomena can best be introduced by a quotation from Roman Jakobson (1958): "A linguistic typology based on arbitrarily selected traits cannot yield satisfactory results, any more than the classification of the animal kingdom which instead of the productive division into vertebrates and non-vertebrates, mammals and birds, etc., would use, for instance, the criterion of skin colour and on this basis group together, e.g., white people and light pigs." This consideration has a bearing on the question whether and which quantitative aspects can function as substantial typological features. Do there exist quantitative traits essential for the classification of languages?

As an example of an unproductive and arbitrary criterion Jakobson quotes colour, which is a qualitative trait. He could just as well have quoted a quantitative trait, for instance the weight of animals. But nobody would regard the classification of animals according to their weight as using an essential trait. Similarly inappropriate would it be to classify animals according to the number of individuals. We must take into consideration that in zoology the quantitative aspect is not so closely connected with the qualitative aspect as it is in other sciences. Of course, we use quantitative classifiers even in zoology (e.g. the classification of animals into artiodactyls and perissodactyls), not because this classification contributes an essential trait to the differentiation, but because it is a classifier which has been verified in practice. It has nothing to do with the qualitative properties of each respective species of animals.

In some other sciences, e.g. in chemistry and physics, it is, however, quite different. It is well known that in those sciences the relation between quantity and quality is very close, one can even pass into the other. A similar, very close relation between quantity and quality exists also in linguistics[1], though the conditions of the transition of quantity into quality are not so thoroughly ascertained as they are in natural sciences. However, we are sure that in linguistics all qualitative changes assert themselves with the help of quantitative factors (i.e. they depend upon the frequency of occurrence of the innovations in question).

Thus the necessity of a quantitative investigation into qualitative facts or changes without which qualitative facts do not possess their full value and relevance, answers the first question in the affirmative. If we regard the quantitative aspect as essential for the evaluation of any linguistic fact, we must admit the importance of a quantitative evaluation even for typology. Of course, we must be careful to choose quantitative traits which are really essential for the classification of languages, in other words, we must choose really characteristic traits.

Vladimír Skalička (1958) distinguishes five conceptions of typology: (1) the classificatory (taxonomic) conception, (2) the conception of characterization, (3) the conception of the classification of particular traits, (4) the conception of gradual typology, and (5) the investigation of the relations between particular language facts. Quantitative methods are most often used when languages are classified according to the third and fourth conceptions.

From the typologies of the third conception (the conception of the classification of particular language traits) we shall mention the typology of A. Isačenko (1939) who classified Slav languages according to the relative frequency of vowel and consonant phonemes of the inventory of particular languages. On this basis, Slav languages can be classified into three types: (1) radically vocalic, (2) radically consonantal, (3) mixed type. To the fundamental classification into vocalic and consonantal types Isačenko was led by the fact that there are two groups of Slav languages: those distinguishing hard and soft consonants and those which possess no correlation of palatalization, but have musical pitch. Languages possessing a highly developed system of consonant phonemes, as for instance Polish, have a poor vocalic inventory, and *vice versa*, languages possessing a rich vocalic inventory, as for instance Serbo-Croatian, have a poor consonant inventory. This theory being applied to Germanic and Romance languages, the Germanic languages appear to be prevalently vocalic and the Romance languages appear to be prevalently consonantal. The present writer has expanded this theory by comparing the occurrence of vowels and consonants in the phonemic

[1] *Cf. J. Vachek, On the interplay of quantitative and qualitative aspects in phonemic development.* Zeitschrift für Anglistik und Amerikanistik, 5. Jahrg. 1957, Heft 1, 28 : " . . . *as a rule, the quantitative facts of language appear to be closely co-ordinated with qualitative language facts . . .* "

inventory with the occurrence of vowels and consonants in coherent texts[2]. The statistical investigation of eight languages showed that in texts German and English have a greater relative frequency of consonants than in the phonemic inventory, whereas the other languages examined, i.e. Czech, Old English, Italian, Spanish, Slovak, and Persian, make more use of vowels in texts. If we want to express the exploitation of vowels (V) numerically, we relate the percentage of consonants of the phonemic inventory (Pi) to the percentage of consonants in the text (Pt), the equation being

$$V = \frac{Pi}{Pt}$$

Values larger than 1·00 mean an over-exploitation of vowels (i.e. the percentage of occurrence of vowels in texts is larger than the percentage of vowels in the inventory), values smaller than 1·00 mean an under-exploitation of vowels (i.e. the percentage of occurrence of vowels in texts is smaller than the percentage of vowels in the inventory). Consequently, the more vocalic a language is, the more the consonantal elements assert themselves in particular texts, and *vice versa*, the more consonantal a language is, the more frequent are the vowels in particular texts of such a language. Languages of the consonantal type choose and frequently make use of words of such structure that their consonantal character is denied. Thus, for example in Czech, which is a language of the consonantal type, in texts words are frequently inserted in which the vocalic elements are balanced with the consonantal elements or the vocalic elements are even prevalent. The same is true, *mutatis mutandis* in languages of the vocalic type.

When classifying languages into vocalic and consonantal, we characterize them by that classification—only very roughly, of course—in the phonic aspect. There is no doubt that the phonic image of the language is one of the most important characteristics of any language ; it is a complex summation of all factors and facts by which the language manifests itself in its acoustic form. However, we are not able so far to grasp it in all its complexity nor in such a way that a comparison of different languages, and, consequently, the classification of languages into different types, is possible. Thus a certain simplification is necessary. It is equally clear that only a quantitative treatment of particular phenomena which characterize the language as far as the sound is concerned, can lead to a characterization of the language in that respect. Of course, we must look for the most characteristic trait which is common to several phenomena. Thus, for example, it would not be practical to compare individual sounds, as each of them has a different articulation and a different acoustic effect. And if we compared different sounds only as to the frequency of occurrence we should be hardly able to find a classifier by which to classify languages.

[2] Cf. J. Krámský, *Fonologické využití samohláskových fonémat (Phonological exploitation of vocalic phonemes)*. Linguistica Slovaca, IV-VI, 1946-48, 39. Cf. also Vl. Skalička, *Typologie slovanských jazyků, zvláště ruštiny (Typology of Slav languages, especially of Russian)*. Československá rusistika, 1958, N. 2-3, 73.

But we know that certain groups of sounds share some common articulatory features. Therefore it will be best to attempt a quantitative typology on the basis of the usual classification of sounds. In this paper we are concerned with the classification of consonants. They can be classified according to the manner of articulation and according to the place of articulation. According to the manner of articulation, consonants are classified into three groups: (1) plosives and affricates, (2) fricatives, (3) nasals, liquids and semivowels. According to the place of articulation, consonants are classified into four groups: (1) labials, (2) alveolars (or dentals), (3) palatals, (4) velars. If we are to compare several languages as to the frequency of occurrence of consonants of a certain kind, a mere statement of the frequency of occurrence of consonants in each language would be insufficient, as the conditions of their occurrence are not the same in all languages. The absolute frequency of particular kinds of consonants could not be compared, as the compared languages have not the same number of consonantal phonemes of a certain kind in their phonemic inventories so that the data would be inadequate and misleading. It is not our aim to search for a mere frequency of occurrence of consonants, but for their exploitation in the text in comparison with their inventory. We start from the consideration that if the exploitation of consonants of a certain kind in a text were equal, it would relatively equal the percentage of occurrence of the same kind of consonants in the phonemic inventory. For instance, if there are 8 different plosives, 6 different fricatives and 6 different nasals (i.e. 40% : 30% : 30%) in the phonemic inventory, and 50% of plosives, 20% of fricatives and 30% of nasals in the text, the differences in the relative frequency between the inventory and the text, making 10% with plosives and − 10% with fricatives, give the deviations from the equal exploitation of the kinds of consonant examined. The positive deviation means an over-exploitation, the negative deviation means an under-exploitation of the consonants in question. Thus our method is based on the assumption of an equal functional burdening of particular kinds of sound[3] in the case of neutral behaviour on the part of the language toward all kinds of sound and, consequently, to all manners and places of articulation. But languages mostly exploit certain kinds of sound more than others and it is this fact that makes languages characteristic in one way or another, as far as the sound or acoustic aspect of language is concerned. It is just the exploitation of sounds, i.e. the relation of the sounds of the language inventory to the relative occurrence in texts, which characterizes individual languages.

Our task was to find out the frequency of occurrence of phonemes in coherent texts in 23 languages. We tried to make a comparatively representative choice of languages. Our choice was, however, limited by the possibility of procuring a reliable phonetic or phonemic transcription of literary texts of various languages. Another limitation was the fact that the work was done by a single researcher only. Such an extensive

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[3] *The same method has been used in the statistical evaluation of the mutual relation of particular consonantal positions in the word (cf. the author's paper* On the quantitative phonemic analysis of English mono- and disyllables, *Časopis pro moderní filologii, 38, 1956, Supplement Philologica, 45.*

TABLE 1

	Number of vowels		consonants		Total	Phonemes per word	Number of words
	absol.	%	absol.	%			
1. Ishkashimi	859	41.6	1205	58.4	2064	4.21	490
2. Kalai-Khumb	903	42.2	1234	57.8	2137	4.44	481
3. Turkish	1260	42.1	1733	57.9	2993	6.12	489
4. Chuvash	1087	42.1	1492	57.9	2579	5.16	500
5. Inamwanga	1729	51.0	1663	49.0	3392	5.86	579
6. Gola	772	48.7	814	51.3	1586	3.61	439
7. Siane	1709	50.9	1643	49.1	3252	5.52	608
8. Sakalava	1144	50.2	1137	49.8	2281	5.66	403
9. Arapaho	1431	46.4	1656	53.6	3087	10.25	301
10. Albanian	1793	47.4	1989	52.6	3782	4.60	822
11. Indonesian	1228	44.0	1562	56.0	2790	5.59	499
12. French	1063	44.2	1339	55.8	2402	3.00	800
13. Russian	1299	42.0	1791	58.0	3090	4.95	624
14. German	835	37.1	1417	62.9	2252	4.33	520
15. English	899	37.6	1493	62.4	2392	3.07	779
16. Lakh	1204	41.6	1692	58.4	2896	5.18	559
17. Armenian	1531	39.6	2336	60.4	3867	6.29	614
18. Japanese	1256	51.5	1184	48.5	2440	3.84	636
19. Czech	1199	41.8	1666	58.2	2865	4.85	590
20. Bulgarian	773	56.3	599	43.7	1372	3.43	400
21. Chinese	964	47.1	1081	52.9	2045	4.94	414
22. Arabic	1450	44.7	1791	55.3	3241	6.07	534
23. Hausa	1166	48.5	1236	51.5	2402	3.37	712

investigation of a considerable number of languages ought to be done by a collective body of research workers. Nevertheless, the number of 23 languages seems to be representative enough to make possible certain conclusions from the investigation.

Indo-European languages are represented in our study by ten languages: the Iranian group is represented by two minor dialects, namely by the Kalai-Khumbian dialect of Tajiki and the Pamir dialect of Ishkashimi. The Slav group is represented by Russian, Czech, and Bulgarian, the Germanic group by German and English, the Romance group by French. Albanian and Armenian are also examined. Semitic languages are represented by Arabic, Hamitic languages by Hausa, Caucasian languages by Lakh, Turkish languages by Turkish and Chuvash, Sino-Tibetan languages by Chinese. From the group of Indonesian languages we have examined Indonesian and Sakalava, a language spoken on the north-western coast of Madagascar. Languages of New Guinea are represented by Siane, a language belonging to the group of Bena-Bena. African languages are represented by Gola and Inamwanga, American languages by Arapaho (spoken in the state of Wyoming), and the languages of

the Far East by Japanese. Although not all language groups are represented, yet the choice of languages examined seems representative enough for the purpose of our investigation.

The texts from these languages contained from 1,372 to 3,867 phonemes. The total number of phonemes in all texts examined was 61,307 phonemes, out of which vowels number 27,554 and consonants, 33,753 (cf. Table 1).

The survey of the frequency of occurrence of consonants classified according to the manner or place of articulation can be seen from Tables 2 and 3 respectively. This statistical survey does not provide a basis for comparing the distributions of particular kinds of sound, because it gives only the absolute frequency of occurrence. The relative frequency of occurrence stated as a percentage for particular kinds of consonant is given in Table 4. It is interesting that there are not too great deviations in the percentage of occurrence of particular kinds of consonant according to the manner of articulation. Thus the relative frequency of occurrence of plosives varies between 23·6% (Sakalava) and 42·8% (Albanian, Japanese), of fricatives between 12·3% (Inamwanga) and 33·4% (Czech), and of nasals and liquids between 27·1% (Arapaho) and 59·7% (Inamwanga). As to the consonants according to the place of articulation, the differences are considerable: they vary between 4·8% (Arapaho) and 28·1% (Siane) for labials, between 33·8% (Gola) and 71·6% (German) for alveolars, between 0·1% (Sakalava) and 26·3% (Chinese) for palatals, and between 7·7% (French) and 48·5% (Arapaho) for velars.

Table 5 contains relative frequencies of particular kinds of consonant in the phonemic inventory. The comparison of this relative frequency of occurrence with the relative frequency of particular kinds of consonant in texts gives the deviation (positive or negative) from the equal distribution as assumed in the ideal case. The deviations are recorded in Table 6. As mentioned above, a positive deviation means an over-exploitation, a negative deviation means an under-exploitation of a certain kind of consonant. Besides, we must bear in mind that positive and negative deviations are compensated so that for instance an over-exploitation of plosives is compensated by an under-exploitation of fricatives and nasals, or an under-exploitation of fricatives is compensated by an over-exploitation of plosives and nasals. According to this principle it is possible to classify languages into several types. Comparing consonants according to the manner of articulation, we can distinguish three types of language[4]:

Type I. Languages positively exploiting plosives and nasals :

1. Kalai-Khumb
2. Indonesian
3. Ishkashimi
4. German
5. Albanian
6. French
7. English

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[4] *Languages in particular types are arranged in order from the largest to the smallest positive deviation (or the sum of positive deviations).*

TABLE 2

Absolute frequency of consonants according to the manner of articulation

	Plosives				Fricatives				Nasals and liquids			
	Init.	Mid.	Fin.	Total	Init.	Mid.	Fin.	Total	Init.	Mid.	Fin.	Total
1. Iakkashimi	182	162	118	462	143	140	38	321	79	206	137	422
2. Kalai-Khumb	215	170	61	446	86	170	32	288	110	233	157	500
3. Turkish	228	288	56	572	103	208	52	363	60	567	171	798
4. Chuvash	181	229	50	460	160	169	36	365	62	431	174	667
5. Iramenga	75	391	-	466	25	179	-	204	184	809	-	993
6. Gola	220	63	-	283	122	16	-	138	213	151	29	393
7. Stano	165	318	3	486	60	149	1	210	223	723	1	947
8. Sakalava	49	219	-	268	103	197	-	300	160	407	2	569
9. Arapho	28	452	87	567	181	456	4	641	92	296	60	448
10. Albanian	367	417	66	850	154	190	38	382	219	422	116	757
11. Indonesian	261	340	52	653	42	96	56	194	112	417	186	715
12. French	267	138	64	469	162	119	45	306	139	249	156	544
13. Russian	232	356	75	663	151	261	34	446	135	448	99	682
14. German	134	191	85	410	186	144	75	405	72	279	251	602
15. English	151	129	223	503	278	72	91	441	173	202	174	549
16. Lakh	358	263	13	634	98	249	19	366	63	429	200	692
17. Armenian	180	432	94	706	148	270	78	496	111	763	260	1134
18. Japanese	210	288	-	498	116	99	-	215	219	231	21	471
19. Czech	196	329	56	581	220	299	37	556	94	339	96	529
20. Bulgarian	101	123	19	243	48	78	11	137	50	130	39	219
21. Chinese	224	186	2	410	117	65	2	182	80	256	153	489
22. Arabic	144	435	-	561	152	233	-	387	243	474	126	843
23. Hausa	331	172	-	503	133	40	1	174	213	251	95	559

TABLE 3

Absolute frequency of consonants according to the place of articulation

		Labials				Alveolars				Palatals				Velars			
		Init.	Mid.	Fin.	Total	Init.	Mid.	Fin.	Total	Init.	Mid.	Fin.	Total	Init.	Mid.	Fin.	Total
1.	Ishkashimi	104	94	46	244	158	295	172	625	52	50	24	126	90	69	51	210
2.	Kalai–Khumb	148	105	51	304	115	276	165	556	50	97	15	162	98	94	19	211
3.	Turkish	126	144	51	321	91	691	165	947	46	126	30	202	128	102	33	263
4.	Chuvash	137	106	48	291	142	573	170	885	51	78	12	141	73	72	30	175
5.	Inamwanga	130	386	-	516	96	681	-	777	10	135	-	145	48	177	-	225
6.	Gola	104	125	4	233	181	74	20	275	164	24	-	188	106	7	5	118
7.	Siane	139	323	-	462	127	708	2	837	-	-	-	-	182	159	3	344
8.	Sakalava	133	133	-	266	145	532	-	677	-	-	2	2	34	158	-	192
9.	Arepsho	14	64	2	80	88	532	71	691	12	69	1	82	187	539	77	803
10.	Albanian	235	166	19	400	358	674	177	1209	35	7	-	42	94	126	18	238
11.	Indonesian	120	166	19	305	188	539	159	886	1	39	4	44	72	141	116	329
12.	French	167	105	17	289	334	338	230	902	50	159	25	234	66	24	14	104
13.	Russian	181	167	40	388	208	642	117	967	5	-	-	5	79	97	26	202
14.	German	111	76	22	209	214	451	349	1014	7	-	-	7	62	87	40	189
15.	English	160	77	40	277	307	301	404	1012	113	185	14	312	18	25	4	47
16.	Lakh	40	145	5	190	351	584	208	1143	39	141	1	181	116	230	29	375
17.	Armenian	143	172	91	406	141	922	311	1374	77	80	-	157	106	84	-	190
18.	Japanese	114	73	-	187	248	381	21	650	65	116	4	185	58	109	42	209
19.	Czech	132	181	52	365	255	561	91	907	25	27	19	71	38	32	6	76
20.	Bulgarian	47	71	12	130	89	201	32	322	125	111	48	284	74	128	7	209
21.	Chinese	66	40	-	106	156	321	105	582	16	115	-	131	35	74	-	109
22.	Arabic	174	197	7	378	202	613	121	936	139	44	-	183	147	197	2	346
23.	Hausa	146	87	5	238	293	223	90	606	—	—	—	—	99	109	1	209

TABLE 4(a)

Relative frequency (%) of

	Plosives				Fricatives				Nasals			
	Init.	Mid.	Fin.	Total	Init.	Mid.	Fin.	Total	Init.	Mid.	Fin.	Total
1. Iehkashind	15.1	13.5	9.8	38.4	11.8	11.6	3.1	26.6	6.6	17.1	11.4	35.0
2. Kalat-Khumb	17.4	13.8	4.9	36.1	6.9	13.8	2.6	23.3	8.9	19.0	12.7	40.6
3. Turkish	13.2	16.6	3.2	33.0	5.9	12.0	3.0	20.9	3.5	32.7	9.9	46.1
4. Chuvash	12.1	15.3	3.4	30.8	10.7	11.4	2.4	24.5	4.1	28.9	11.7	44.7
5. Inanwanga	4.5	23.5	-	28.0	1.5	10.8	-	12.3	11.1	48.6	-	59.7
6. Gola	27.0	7.7	-	34.7	15.0	2.0	-	17.0	26.2	18.5	3.6	48.3
7. Siere	10.1	19.3	0.2	29.6	3.6	9.1	0.1	12.8	13.5	44.0	0.1	57.6
8. Sakalava	4.3	19.3	-	23.6	9.1	17.3	-	26.4	14.1	35.8	0.1	50.0
9. Arapaho	1.7	27.3	5.2	34.2	10.9	27.5	0.3	38.7	5.6	17.9	3.6	27.1
10. Albanian	18.5	21.0	3.3	42.8	7.7	9.6	1.9	19.2	11.0	21.2	5.8	38.0
11. Indonesian	16.7	21.8	3.3	41.8	2.7	6.1	3.6	12.4	7.2	26.7	11.9	45.8
12. French	19.9	10.3	4.8	35.0	12.1	8.9	3.4	24.4	10.4	18.6	11.6	40.6
13. Russian	12.5	19.9	4.2	37.0	8.4	14.6	1.9	24.9	18.6	25.0	11.9	38.1
14. German	9.4	13.6	5.9	28.9	13.1	10.1	5.4	28.6	7.6	19.7	5.5	42.5
15. English	10.1	8.7	14.9	33.7	18.6	4.8	6.1	29.5	5.1	25.0	5.5	36.8
16. Lakh	21.2	15.5	0.8	37.5	6.3	14.7	3.4	21.6	19.7	13.5	17.1	40.9
17. Armenian	7.7	18.5	4.0	30.2	9.8	11.6	1.4	21.3	4.8	25.4	11.7	48.5
18. Japanese	17.7	24.3	-	42.0	8.4	8.4	2.3	18.2	3.7	32.6	11.8	39.8
19. Czech	11.8	19.8	3.3	34.9	13.2	18.0	1.4	33.4	5.6	19.5	11.1	31.7
20. Bulgarian	16.9	20.5	3.2	40.6	6.3	13.2	1.9	22.9	8.3	20.3	1.8	36.5
21. Chinese	20.7	17.2	-	37.9	9.8	46.0	-	16.8	7.4	21.7	5.8	45.3
22. Arabic	8.0	23.2	0.1	31.3	10.8	13.0	0.1	21.6	13.6	23.7	14.2	47.1
23. Hausa	26.8	13.9	-	40.7	10.7	3.2	0.1	14.0	17.2	26.5	7.0	45.3

TABLE 4(b)

Relative frequency (%) of

	Labials				Alveolars				Palatals				Velars			
	Init.	Mid.	Fin.	Total	Init.	Mid.	Fin.	Total	Init.	Mid.	Fin.	Total	Init.	Mid.	Fin.	Total
1. Iahkaahimi	8.7	7.8	3.8	20.3	13.1	24.5	14.2	51.8	4.3	4.2	2.0	10.5	7.5	5.7	4.2	17.4
2. Kalai-Khumb	12.0	8.5	4.1	24.6	9.3	22.4	13.3	45.0	4.1	7.9	1.2	13.2	8.0	7.6	1.6	17.2
3. Turkish	7.3	8.3	2.9	18.5	5.2	39.9	9.9	54.6	2.7	7.3	1.7	11.7	7.4	6.1	1.6	15.2
4. Chuvash	9.2	7.1	3.2	19.5	9.5	38.4	11.4	59.3	3.4	5.3	0.8	9.5	4.9	4.8	2.0	11.7
5. Inemwanga	7.8	23.2	-	31.0	5.8	41.0	-	46.8	0.6	8.1	-	8.7	2.9	10.6	-	13.5
6. Gola	12.8	15.3	0.5	28.6	22.2	9.1	2.5	33.8	20.1	3.0	-	23.1	13.0	0.9	0.6	14.5
7. Siera	8.5	19.6	-	28.1	7.7	43.1	0.2	51.0	-	-	-	-	11.1	9.6	0.2	20.9
8. Sakalava	11.7	11.7	-	23.4	12.8	46.8	-	59.6	-	-	0.1	0.1	3.0	13.9	-	16.9
9. Arepako	0.8	3.9	0.1	4.8	5.3	32.1	4.3	41.7	0.7	4.2	0.1	5.0	11.3	32.5	4.7	48.5
10. Albanian	10.8	8.3	1.0	20.1	18.0	33.9	8.9	60.8	3.7	3.2	0.3	7.2	6.3	5.1	0.5	11.9
11. Indonesian	7.7	10.6	1.2	19.5	12.0	34.5	10.2	56.7	2.3	0.4	-	2.7	9.0	9.6	2.5	21.1
12. French	12.5	7.8	1.3	21.6	25.0	25.2	17.2	67.4	0.1	2.9	0.3	3.3	1.8	5.4	0.5	7.7
13. Russian	10.1	9.3	2.3	21.7	11.6	35.9	6.5	54.0	2.8	8.9	1.4	13.1	4.6	5.4	1.2	11.2
14. German	7.8	5.4	1.6	14.8	15.1	31.8	24.7	71.6	-	-	-	-	9.0	1.0	3.0	13.3
15. English	10.7	5.2	2.7	18.6	20.8	34.5	12.3	67.6	0.5	-	-	0.5	7.5	2.7	3.0	13.2
16. Lakh	2.3	8.6	0.3	11.2	20.6	20.1	27.0	67.7	6.7	10.9	0.8	18.4	1.0	1.6	0.3	2.8
17. Armenian	6.1	7.3	3.9	17.4	6.0	39.5	13.3	58.8	1.6	6.0	0.1	7.7	9.2	6.6	0.3	16.1
18. Japanese	9.6	6.2	-	15.8	20.9	32.2	1.8	54.9	6.5	6.8	-	13.3	8.9	7.1	1.2	12.6
19. Czech	7.9	10.9	3.1	21.9	15.3	33.7	5.4	54.4	3.9	7.0	0.2	11.1	5.0	6.6	1.0	12.6
20. Bulgarian	7.8	11.9	2.0	21.7	15.3	33.6	5.3	53.7	4.2	4.5	3.2	11.9	5.0	6.6	1.2	12.7
21. Chinese	6.1	3.7	-	9.8	14.8	29.7	9.7	53.9	-	10.3	4.4	26.3	3.5	6.6	1.0	10.0
22. Arabic	9.7	10.0	0.4	21.1	11.3	34.2	6.8	52.3	11.6	6.4	-	7.3	6.3	3.2	11.0	19.3
23. Hausa	11.8	7.0	0.4	19.2	23.8	18.0	7.3	49.1	11.2	3.6	-	14.8	8.0	8.8	0.1	16.9

TABLE 5

	Relative frequency (%) of consonants in the phonemic inventory						
	Plos.	Fric.	Nas.	Lab.	Alv.	Pal.	Vel.
1. Ishkashimi	36.7	43.3	20.0	20.0	36.7	23.3	20.0
2. Kalai-Khumb	33.4	45.8	20.8	25.0	29.2	20.8	25.0
3. Turkish	40.0	35.0	25.0	25.0	35.0	20.0	20.0
4. Chuvash	37.9	34.5	27.6	20.7	44.8	20.7	13.8
5. Inamwanga	35.0	25.0	40.0	30.0	35.0	15.0	20.0
6. Gola	36.3	27.3	36.4	30.3	21.2	33.3	15.2
7. Siane	35.7	21.4	42.9	42.9	35.7	-	21.4
8. Sakalava	45.0	25.0	30.0	25.0	45.0	5.0	25.0
9. Arapaho	41.7	33.3	25.0	16.7	33.3	16.7	33.3
10. Albanian	41.4	31.0	27.6	17.2	48.3	17.2	17.3
11. Indonesian	36.4	31.8	31.8	22.7	45.5	9.1	22.7
12. French	33.3	33.3	33.4	27.8	55.6	5.5	11.1
13. Russian	40.0	34.3	25.7	28.6	42.9	11.4	17.1
14. German	28.6	42.8	28.6	28.6	42.8	4.8	23.8
15. English	33.3	37.5	29.2	25.0	54.2	4.2	16.6
16. Lakh	53.7	36.6	9.7	12.2	48.8	31.7	7.3
17. Armenian	50.0	30.0	20.0	20.0	56.7	3.3	20.0
18. Japanese	47.4	26.3	26.3	26.3	36.9	21.0	15.8
19. Czech	40.0	36.0	24.0	20.0	48.0	16.0	16.0
20. Bulgarian	41.7	33.3	25.0	27.8	41.7	13.9	16.6
21. Chinese	47.8	26.1	26.1	21.7	43.5	21.7	13.1
22. Arabic	31.5	46.3	22.2	14.8	51.8	7.4	24.0
23. Hausa	54.0	19.0	27.0	19.0	32.4	27.0	21.6

Type II. Languages positively exploiting fricatives and nasals (the least productive type) :

1. Sakalava
2. Arapaho

Type III. Languages positively exploiting nasals and liquids (the most productive type) :

1. Lakh
2. Armenian
3. Arabic
4. Turkish
5. Inamwanga
6. Chinese
7. Hausa
8. Chuvash
9. Siane

TABLE 6

	Deviations (%) from equal distribution of consonants						
	Plos.	Fric.	Nas.	Lab.	Alv.	Pal.	Vel.
1. Ishkashimi	1.7	-16.7	15.0	0.3	15.1	-12.8	-2.6
2. Kalai-Khumb	2.7	-22.5	19.8	-0.4	15.8	-7.6	-7.8
3. Turkish	-7.0	-14.1	21.1	-6.5	19.6	-8.3	-4.8
4. Chuvash	-7.1	-10.0	17.1	-1.2	14.5	-11.2	-2.1
5. Inamwanga	-7.0	-12.7	19.7	1.0	11.8	-6.3	-6.5
6. Gola	-1.6	-10.3	11.9	-1.7	12.6	-10.2	-0.7
7. Siane	-6.1	-8.6	14.7	-14.8	15.3	-	-0.5
8. Sakalava	-21.4	1.4	20.0	-1.6	14.6	-4.9	-8.1
9. Arapaho	-7.5	5.4	2.1	-11.9	8.4	-11.7	15.2
10. Albanian	1.4	-11.8	10.4	2.9	17.0	-10.0	-5.4
11. Indonesian	5.4	-19.4	14.0	-3.2	11.2	-6.4	-0.6
12. French	1.7	-8.9	7.2	-6.2	11.8	-2.2	-3.4
13. Russian	-3.0	-9.4	12.4	-6.9	11.1	1.7	-5.9
14. German	0.3	-14.2	13.9	-13.8	28.8	-4.5	-10.5
15. English	0.4	-8.0	7.6	-6.4	13.5	-3.7	-3.4
16. Lakh	-16.2	-15.0	31.2	-1.0	18.8	-13.3	4.5
17. Armenian	-19.8	-8.7	28.5	-2.6	2.1	4.4	-3.9
18. Japanese	-5.4	-8.1	13.5	-10.5	18.0	-7.7	0.2
19. Czech	-5.1	-2.6	7.7	1.9	6.4	-4.9	-3.4
20. Bulgarian	-1.1	-10.4	11.5	-6.1	12.0	-2.0	-3.9
21. Chinese	-9.9	-9.3	19.2	-11.9	10.4	4.6	-3.1
22. Arabic	-0.2	-24.7	24.9	6.3	0.5	-0.1	-4.7
23. Hausa	-13.3	-5.0	18.3	0.2	16.7	-12.2	-4.7

10. Japanese

11. Russian

12. Gola

13. Bulgarian

14. Czech

Type III is the most clear-cut, as it positively exploits nasals as against the under-exploitation of all other kinds of consonant. Common to all three types is the over-exploitation of nasals, but they differ in the exploitation of plosives and fricatives. The over-exploitation of plosives is, however, not so marked as the over-exploitation of nasals, and, consequently, languages of Type I come near some languages of Type III. It is a remarkable observation that among the languages examined not a single one was found showing an under-exploitation of nasals.

Comparing consonants according to the place of articulation, we can distinguish four types of language[4] :

Type I. Languages over-exploiting labials and alveolars :
1. Albanian
2. Hausa
3. Ishkashimi
4. Inamwanga
5. Czech
6. Arabic

Type II. Languages over-exploiting alveolars :
1. German
2. Turkish
3. Lakh
4. Kalai-Khumb
5. Siane
6. Sakalava
7. Chuvash
8. English
9. Gola
10. Bulgarian
11. French
12. Indonesian

Type III. Languages over-exploiting alveolars and palatals :
1. Chinese
2. Russian
3. Armenian

Type IV. Languages over-exploiting alveolars and velars :
1. Arapaho
2. Japanese

The most clear-cut of these types and the most productive too, is Type II which exploits alveolars and under-exploits all other kinds of consonant.

The present investigation forms only the beginning and it is necessary to supplement it by the examination in this respect of other languages, especially of such as have either a very rich or a very poor inventory of consonantal phonemes. Besides, it will be necessary to link up the question of the exploitation of different kinds of consonantal phoneme with the question of the exploitation of different kinds of vocalic phoneme. Our investigation in that respect has so far not reached clear-cut and reliable results. The comparison is here rendered more difficult by the fact that the limits between particular kinds of vowel (for example between front, middle, and back vowels) are not so well defined as for instance the limits between plosives and nasals, or between labials and velars. Perhaps we shall reach some results (even if negative ones), if we begin by comparing languages of identical vocalic systems but with different types of exploitation of consonants.

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FRIES ON WORD CLASSES

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Examination of " The Structure of English " (Fries, 1952) has led to the following conclusions. The attempt by Fries to handle parts of speech as structural meaning units into which word classes enter, shows an attempt to deal with too many features of English at one time. Although it may be seen that he was aiming to present the diversity of free form patternings in which words with certain bound form ranges can occur, the result has provided suggestions for future research, rather than a clear statement of the formal characteristics of English words. The definitive criteria for the parts of speech are not precise, and there is also a tendency to proceed from meaning assumptions to form, instead of from form to meaning by way of strict descriptive analysis. Some ideas about the nature of syntactic classes (and constants) are introduced and related to Fries's views.

1.0. FUNDAMENTAL CLAIMS

1.01. In preparation for discussion about Fries's work, some basic ideas for the analysis and presentation of English word classes may be stated.

Distributional studies will show that it is often valuable to keep the study of the classification of words according to the bound forms they may take, separate from one which describes the words as free forms in positional arrangements with each other. When the two activities are confused it can be easy to create classes that do not have consistent and clear cut characteristics. Here we use ' word ' as a term for a free form which may contain inflection or word formation[1], as well as for one which contains no bound forms at all.

It is a feature of English that a class of words capable of using a specific range of inflectional endings, may enter a free form structural sequence in the same position as one or more classes capable of being characterized by different inflectional endings.

[1] *For an explanation of what is meant by "Word Formation" see Harwood, F. W., and Wright, Alison M.,* Statistical Study of English Word Formation, *Language, 32 (1956), p. 260 foll.*

Thus the position need not be a unique marker of one class and cannot be used to describe it in this way.

On the one hand the inflections of words may be grouped to define and characterize parts of speech, and on the other, the positions which one or more of these parts of speech can enter, may be stated separately in order to describe their behaviour. Perhaps a re-definition of the constructed classes may follow for various purposes. There would be subdivisions, for example, within an inflectional group because *boy+s* but not *boy+'s*, will appear in *The — walked over the bridge*. There would also be new groupings because a variety of inflection classes will fit such frames as *the —*, or *the n+o v+s —*.[2]

It can happen, as in Fries, that theory leads some words with the same free form positions to be classed as ones having the same inflectional endings. But it is not possible to say that both types of frame consistently provide the same members. The tendency to place free form positional frames in which word classes with certain inflections may enter, as characteristics of these same classes, has not always been discriminate.

1.02. A method of analysing an English text recommended in this paper, is to set up classes of words which all take the same set of inflections, and then to examine where these inflections occur in positional sequence. Thus *+'s* occurs on a single morpheme word of the noun inflection class in *The boy's coat is on the hook*, while the other inflections are excluded. A formation rule can be introduced to this effect.

Where we find a member of a class, such as *n/v* or *n/a*, which takes more than one set of the inflections which mark out an already defined class, the following procedure can be adopted. We state, for example, that the members are to be noted as either nouns or verbs, but not both, according to the particular inflection (not *+ o*) used in the given frame, and according to whether a member of the exclusive noun or verb class will occur in the same position. Thus in *The boy hits the ball, hits* cannot

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[2] *The key to the use of symbols is as follows :*

t :	*determiners*
n :	*nouns*
v :	*verbs*
a :	*adjectives*
c :	*conjunctions*
p :	*prepositions*
r :	*auxiliaries*
m :	*personal pronouns*
i :	*interrogatives*
d :	*adverbs which have some similarities with a + ly.*

+s, +ing, etc. indicate inflections, and +o the absence of inflection. +o is not to be confused with a bound form and has notational significance only. Some morpheme elements will occur in the formulas as constants.

The notation however provides only a loose method of illustration. It is by no means an attempt to record the syntax of English with any accuracy. Much subdivision and re-organization is needed of the classes just quoted.

be treated as $n+s$ because no member of the exclusive n class ever appears in such a frame. Again, in *The men worked hard,* $+ed$ and the position of *work* in relation to the rest of the sentence makes *work* a verb and never a noun.

In other cases we may find words which take more than one set of inflections (with each set capable of characterizing a separate class) occurring with a zero bound form. In these circumstances the test of whether a member of one of the unique classes can appear, will again determine the symbol which is to be used to denote the form of the word in question. Thus in *He likes the amenities and the work,* and *The aim of sport is to improve the body, but that of study is to improve the mind, work, aim, sport, study* and *mind* must all be marked as n because only members of the exclusive n class will appear in these positions. In a similar way verb and adjective overlap can be treated in, for example, *the mature philosophy.* Again, $v+n$ and $v+d$ can be used to denote the function of $v+o$ in *The children hit by the ball* and *The children hit the ball* etc.

A preliminary analysis of the frames which distinguish one class of words with a particular set of inflections and not another, or which distinguish a class with one particular inflection and not another, has shown that in some cases the overlap cannot be eliminated. For example, take *We discussed the problems as products of the atoms grouped in different ways.* Here *grouped* is either $v+n$ or $v+d$, and the sentence has an ambiguous meaning. But such cases are quite infrequent. They require further research, especially in view of recent suggestion that ambiguities of structure are common,[3] and again in view of recent stress laid upon the need to analyse sound features of spoken language in relation to written language.[4] These last may eliminate ambiguities.

One point, however, is clear: n/a overlap remains in left expansions of nouns. In *the vigorous intellectual effort,* and *the material world, intellectual* and *material* can be treated as either nouns or adjectives, because they take the $+s$ plural, and the $+ly$ inflections, and because the $+o$ forms of both classes occur as here in these positions. The overlap could be treated as a feature of English which enables us to set up a separate class with certain positional characteristics.

We thus see how positional characteristics can be combined with inflectional ones, either to define word classes, or else to provide formation rules for classes defined already by the inflections and other bound forms.

In either case, we may conveniently choose to hold a positional sequence as a feature of one or more classes, each class having a unique inflectional range. There is no need in these circumstances to re-arrange the separate classes already set up, and to create n/v groupings etc. The special position can be treated as selective of a

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[3] (a) *Joos, Martin in a review of* Machine Translation of Languages: Fourteen Essays *by Locke, William N., and Booth, A. Donald (Cambridge, Mass., The Technology Press of the Massachusetts Institute of Technology; New York: John Wiley and Sons, 1955), Language, 32 (1956), p. 293 foll.* (b) *Sledd, James, in his review of Fries (1952), Language, 31 (1955).*

[4] *See Joos, Martin, op. cit., especially p. 298.*

class with a unique inflectional range, which therefore makes the members of overlap classes in this position members of a unique class. (Subdivisions of the classes according to the occurrence of each of the inflections belonging to the unique range—e.g. $+s$ opposed to $+\text{'}s$—would, however, remain). But there will be other cases where a position is not selective of one unique set, as we have seen.

1.03. As a result of these considerations, and because of the variation in syntactic content and length of the position sequences which are capable of determining that one and only one class will occur in instances of formal ambiguity, the following is maintained. It is necessary to examine in turn sequences which may be sentence long, in order to find out what exactly can occur before and after what class symbols. For example, only one class will occur in *The $n+o$ $v+s$ to — him*, but more than one will occur in *He went to —*. It may be that a large number of morpheme positions needs to be examined in some cases before an occurrence of *the* can help to determine one and only one class.

If it is wished to make free forms fixedly diagnostic of a class, then formation rules will also be needed to show under what circumstances, i.e. in what sentence patterns, the diagnostic features hold. Thus too, the circumstances of occurrence of the members of the class will be given. For example, $v+o$, *to*, and *the* could each define a class of words which appears after each of them. Sentence rules would then further determine under what circumstances various sub-classes would occur ; e.g. $n+o$ or $v+o$ after *to*, $v+ing$ or $v+d$ after *the*.

In other words, it is useful in English to examine the occurrence of any individual word class or word constant in relation to each of the possible combinations of the classes and constants in each of the sentence types with both free and bound morphemes marked 1......n in linear order. Thus, for example, in *The — are $a+o$* we can learn that $n+s$, $a+o$ and $v+n$ will occur, but in *— $v+o$ $a+o$*, we can learn that $v+n$ will not occur, and that $a+o$ will do so only in some idiomatic phrases (e.g. *Good makes good*).

The recognition of the need for such exact positional studies has arisen from examination of the work of both Fries and Harris (1951). Fries edged towards them in his theory of diversity of strike. Harris also came to grips with them in his suggestions about approximation techniques, and in his discussion whether long or short environments should be made diagnostic of the same class. (Harris, 1951, Chap. 15. Note pp. 255-6).

1.04. The ideas above arise from the following basic views on the nature of syntactic classes and constants in a given text, where the elements are identified morphemes.

A syntactic constant is a single morpheme which must be used in a particular position in any one of the varied sentences with morpheme positions 1......n, in order to make the sequence a sentence. That is, no other morpheme at all will substitute for it in this particular sequence in order to create the sentence.

A syntactic class is a group of morphemes which satisfies the same conditions. It consists of single morpheme values which all occur where any one occurs in

at least one given position of a sentence. No member or sub-group of a syntactic
class ever occupies one or more exclusive sentence positions.[5]

It follows that the word classes are constructed out of syntactic classes and may
be established in more than one way because of possible choice in defining features.

The enumeration of the serial order of elements is a practice drawn from Carnap
(1937), and also developed from Harris (1951). However, it has already been presented
in a paper by Harwood (1955).

2.0. THE METHODS OF ANALYSIS WHICH FRIES CLAIMS TO USE

2.01. The initial methods by which Fries claims to have established the parts of
speech or word classes are given as follows:

" We have assumed here that all words that could occupy the same ' set of
positions ' in the patterns of English single free utterances must belong to the
same part of speech. We assumed then that if we took first our minimum free
utterances as test frames we could find all the words from our materials that would
fit into each significant position without a change of the structural meaning." (1952,
pp. 74 - 75).

" After using the minimum free utterances we tested the resulting lists [of words] in
the ' positions ' that appeared in the single free utterances that were not minimum
but expanded in various ways." (1952, p. 74).

It is important to realize that except in one instance (1952, p. 78) the ' positions '
referred to by Fries in the test frames consist only of the positions of words as free
forms in relation to one another. (See also 1952, p. 141). (This contrasts with work
done by Harris where the relationships of bound forms to free forms are also initially
considered). The term ' positions ' is consequently always used to refer to free
form occurrences.

The basic features of the procedure then, may be pointed out in this way: (1)
all words which occupy the same set of positions in diagnostic frames will belong
to the same part of speech ; (2) all members of a part of speech will have the same
structural meaning ; (3) tests for both characteristics are to be carried out on minimum
free utterances ; (4) resulting lists of words are to be tested in positions in expanded
utterances.

2.02. However, there is a fundamental modification due to the theory of ' diversity
of strike ' presented earlier and later in the book:

" There is no single characteristic that all the examples of one part of speech must
have in the utterances of English. All the instances of one part of speech are
the ' same ' only in the sense that in the structural patterns of English each has
the same functional significance." (1952, p. 73).

We understand that this means that a part of speech varies in its use of a limited

[5] *It is hoped that the basic ideas briefly given here will be discussed more fully in a future
article. They have been included simply to indicate the writer's approach.*

range of formal devices, according to the structural pattern in which it occurs. These varied patterns are united however, in exhibiting a unit of structural meaning which correlates with the one part of speech. (See 1952, pp. 69 - 70).

Consequently basic qualifications are introduced to the method of discovery described. The remarks indicate for one thing, that words with the same set of positions, that is those words all having a characteristic in common, need not belong to the same part of speech. Yet Fries is not clear that a contradiction in procedure has been made, for he later claims to have used the assumption that words found in the same set of positions will belong to the same part of speech. (1952, p. 110).

2.03. We are really left with a feature of procedure which will be discussed again. A habit of choosing one or more positions as diagnostic of a particular structural meaning appears to have developed at least partly because of the theory of meaning just described, and it conflicts with attempting to find words with all the same sets of positions. It has been hard to decide whether (1), above, is to be followed exclusively or whether other characteristics are to be used.

In any case ' diversity of strike ' makes it essential for us to rely on feature (2) as the means of defining the classes. It will be seen, however, that even this means is not consistently used, and that the whole method of classification becomes quite confused. As Fries himself holds, a control of meaning to the extent of discovering either through responses or an informant, what forms have the same structural meaning, is essential to his work. (1952, pp. 8, 74 - 5, 79 footnote 13). But he does not realize that in theory at least, ' diversity of strike ' makes ' meaning ' the only real defining characteristic for a part of speech ; that it is only through structural meaning that we can bring the different formal features together as characteristics of a single class. For example,

" our analysis starts from a description of the formal devices that are present and the patterns that make them significant *and arrives at the structural meanings as a result of the analysis.*" (1952, p. 57).

This appears to be incorrect. (See also 1952, p. 203). Meaning decisions must be made initially.

2.04. The method of discovery first described is also qualified by remarks in various places concerning the value of bound forms in defining classes, and by the lists of these forms given in Chapter VII. They are said to be discovered through the positional tests in diagnostic frames (1952, p. 79), and are to be separated as markers from the positions themselves (1952, p. 141). (Although diagnostic frames for Class 1 include —*s*). Both are consistently held to mark out the same classes (1952, pp. 74, 110 - 12), and we may see that Fries can attempt to establish this claim through the theory of ' diversity of strike '. For he also recognizes that inflections, as characteristics in isolation, can provide word classes which conflict in membership with the classes of words marked constantly by positions.

" . . . certain formal matters outrank others in determining the class of a function unit in any particular utterance. In general ' position ' markers in any particular sentence supercede morphological or form markers." (1952, p. 141).

But we will see that in practice inflectional ending frequently takes precedence, and that there is indeed a firm dependence on inflection not only for the description of classes, but also as a means for their discovery. It is greater than Fries is aware, and probably due to the fact that there are bound forms which may be made absolutely diagnostic of word classes.

2.05. In summary then of discussion so far, we tend to find that Fries has actually discovered his parts of speech by selecting meanings which seem to have a traditional basis, and by classifying words according to inflections and word formatives (with which the meanings have been associated). Both features may account for the choice of certain of the positions as diagnostic, because a frequency count may show that the word classes thus established occur very commonly or else exclusively in some of the frames.

We may now see from the previous paragraphs that the theory of ' diversity of strike ' has been an attempt to overcome the opposition between positions and bound forms described in 1.01. But we can hope for its success only if a clear knowledge of the structural meaning for each part of speech is known in order to keep it distinct from others, and, it is highly probable, only if one structural meaning is permitted to define it. The theory presents us with a number of problems. We shall see that in practice Fries satisfies neither criterion.

An attempt to follow out his method of discovery is further confused by the fact that we cannot be clear as to what " a part of speech " means. The reader may have already noticed that 2.0 began by using the expression " parts of speech or word classes ". It has also been convenient to describe a part of speech as a " unit of function ", or " a class of words with the same structural meaning ", without any attention to looseness of definition. This is because Fries himself at times describes a part of speech as a functional meaning unit, while at other times he accepts it as a class of words. As a unit of function it permits words to enter more than one part of speech, and satisfies the claim that we are not to list words in classes with constant features, because of ' diversity of strike '. In this case, as we have seen, both positional and bound form frames may be able to define the one part of speech. But as a unit which lists words with characteristics in isolation from their occurrences, the part of speech exhibits the opposition to which we have referred.

With all these remarks now in mind we may proceed to a more detailed study of the confusions in the establishment and description of the classes presented in the work.

3.0. Meaning problems

3.01. One of the first which comes to mind is the fact that the dependence on structural meaning which Fries accepts (1952, footnotes pp. 8, 74 - 5), has permitted the introduction of dubious uses of ' meaning '. For example, it is frequently assumed that some unstated structural meaning belongs to a particular part of speech, though whether it exists or not is never really shown. It may be possible to set up somewhat

different structural meaning units from those usually accepted, with consequent slight change at least in the parts of speech established.

In any case, a concept of structural meaning is never defined in relation to any particular class, and always remains an obscure notion behind each one. For example, when the Class 1 words are divided into three sub-groups by the test of which one of the substitutes *he, she,* or *it* may be used in their place (1952, p. 121), we are told that this activity provides identifying characteristics for important structural meanings discussed in Chapter IX. But the way in which the different meanings are linked into a group to satisfy Class 1 is not explained. Again, we are provided with the old subject and object positions for Class 1, as well as the frames *the* —, and *-s* in frame A. In what way are their structural meanings the same or different, and how do they link up others, and so on ?

In some cases we may even find a primary dependence on meaning in order to pick out a position as diagnostic. A list of Class 4 words will illustrate this point. (1952, p. 139 (d)). It covers a wide variety of words, and in fact, footnotes 16 and 17 on the same page make it clear that a meaning assumption, and not positional analysis of the occurrences of the words, is the means by which they are grouped together.

Consider *We went down*
        The chair is down the garden
        The man down the street

What is it that picks out one of these positions as diagnostic for Class 4 ? What is it that picks out one of the meanings as important for Class 4 ? Perhaps a statistical study could supply some answer. But it does seem that a structural meaning is here first assumed for a position, and that it is set apart. It need not necessarily apply to other uses of the same words.

While a study of structural meanings is of considerable importance, it cannot be arbitrary, and precise methods for their discovery need to be used.

3.02. A second major problem, and one which is recognized by Fries (1952, footnote p. 56), is the difficulty of separating lexical from structural meaning.

A study of individual morphemes in distributional relation to one another will not necessarily show that they belong to one form class. The point is that semantic differences may exclude many morphemes from fitting positions in sequences taken as frames for the descriptive study of morpheme occurrences. In the frames

        The cars — smoothly
        The fires — brightly

how are we to know that a collection of morphemes which fills the blank in the first is the same formally as that which fills the second ? What is to unite the two different semantic groups into one form class ?

It is hoped that the ideas of 1.04 provide a procedure which is proofed against generating semantic combinations in mistake for syntactic ones. It is not meant, however, that large numbers of semantic groupings would not be valid as descriptive analyses if they could be brought under control. They could be useful if formation rules could be given which would develop them into valid sentences of English. But

we must be able to recognize that they do not supply the syntactic nature of the language.

Consider for example, the definition of a syntactic constant in 1.04. Then in *The children — the —s run quick—·., +ly* is the only form which can fill the last blank, while a very large class can fill the second, and a small class, most often prepositions, called *p*, can fill the first. We may consequently name *+ly* a syntactic constant, and the free forms object language or semantic members of two very different syntactic variables. By this theory syntactic elements can be separated from semantic ones.

When we come to setting up word classes in Fries's manner, instead of morpheme classes, we can treat the analysis of the substitutions of more than one morpheme at a time, as a special case of study of sequence substitution.

For example, combinations of morphemes like *v + n* and *n + s* can be treated as members of one class because they can be found in frames like *the —*, but in others they will not substitute for one another in order to create any kind of sentence. That is, they will occur in exclusive positions. It is possible to define words as a class in relation to free forms for one particular kind of sentence, and then re-define them in relation to bound forms for other kinds of sentences.

It is interesting to observe that if small classes such as *t* define a class, we may be able to set up structural meaning units which differ from those Fries would possibly provide.

3.03. This brings us to the final point of discussion about meaning. Because of the previous theories it is held that the two useful meaning conceptions are " lexical " and " structural ", and that the introduction of " social " meaning by Fries is invalid (1952, pp. 294 - 5).

It is really a part of lexical meaning or semantics. Rip's sentence in the first case given by Fries, would convey the social meanings of his time through the emotive or referential values of the words, that is, through their lexicon. Communication breaks down in the second case because while Rip uses one lexicon, his audience of another period uses another. There is no need to set up a basic idea of ' social meaning ' ; instead, we may state the lexicon for any given time or place.

4.0. Significant positions

4.01. Reference has already been made to the question of whether Fries desires to classify words according to selected diagnostic positions in which they occur, or whether he desires to put them in one class if they all occupy the same positions in both minimum and expanded sentences. In either case, question may also be raised concerning the claim that all members of a part of speech will display the same structural meaning. It will be found that in treating the three different points Fries has created some confusion.

4.02. Classificatory theory (1952, pp. 74 - 80, particularly pages 75 and 78), leads to the belief that certain positions are to be held diagnostic for a class, while others are to be considered less important. Thus for Class 1, test frame A seems to be diagnostic, while for Class 2 three test frames are diagnostic (1952, pp. 80 - 1).

It may immediately be asked why the minimum free utterances (in sentences) chosen as frames, hold significant structural positions and meanings for words over and above their other uses. It may be that firstly the sentences themselves are of high frequency, and can be selected to establish parts of speech on this basis alone. But a precise statistical study might make us enquire why other commonly found sentences such as *The boy is in the garden,* of the type t $n+o$ *is* p t $n+o$ are not also selected.

Secondly it may have been realized that there are certain common sentence frames in English which are diagnostic of a particular range of inflections. As Fries uses inflections to describe the parts of speech in Chapter VII, we may suggest that a link between the positional use of a word and its inflectional range was attempted. Thus in the frame *The concert — good,* only the range of Class 2 inflections can appear. But in other frames, *The — was good* and *The clerk remembered —,* words of the form $v+n$, $a+o$ or $a+ly$, and $n+s$ will occur. These are never grouped together in one class, though $a+o$, and $n+o$ are recognized as able to occur in the one structural unit (1952, p. 118)). The frames for Fries remain diagnostic of certain ranges of inflections only and the others are ignored. It is a pity that he failed to pick out frames which were always diagnostic of the inflectional classes he uses in Chapter VII. As has been pointed out, a full study of the arrangements of classes and constants in sentences of varying lengths will probably show that there are a large number of long sequences capable of determining the occurrence of one and only one class symbol in a given sentence pattern.

4.03. However, as the work of Fries now stands, we must immediately recognize that the selection of diagnostic positions is rather arbitrary, and cuts right across the classification of words according to the characteristic that they all occupy the same set of positions. This may also be seen in the fact that no class of words similar to n/v or n/a is ever established (although it is true that ' diversity of strike ' enables a slightly different recognition of such features at times). (See 1952, p. 118.) Again, note that the diversity of positions a Class 4 word may occupy are not made clear. For instance, *often* will appear before *went* in frame C. (1952, pp. 83 - 5.) (There may be some general realization of its patternings in Chapter X, although it is difficult to assess Fries's mind here.)

In short, classification of words according to their same set of positions cannot be reconciled either with the use of selected diagnostic frames, or with classification according to their same sets of inflections.

Nevertheless, it must be pointed out that Fries does consider that the variety of positions a word may occupy are not to be disregarded.

In an attempt to discover what importance the other positions have in relation to the diagnostic positions we may suggest the following. If a word which appears in

the diagnostic position or positions of a class, appears in other positions also, then it will still belong to its diagnostic class no matter what structural meanings belong to those other positions, so long as none of them is one of the diagnostic positions of another class. For example, Fries himself superficially establishes Class 1 as a set whose members all appear in frame A, and which may appear in other frames as sub-groups as well. (1952, p. 78.)

Although such a practice does give us some explanation of how Fries treats the variety of positions in which words may occur, it certainly shows that he does not satisfy the claim that words which occupy the same positions will be classed together.

The procedure might work if the originally selected diagnostic positions for a class always exhibited the occurrence of a range of inflections which corresponds with the range of inflections which are later used to define the same class. We have seen that this is not the case. So although it seems to approach Fries's habits, confusion still remains. It becomes apparent at this stage that there is really no consistent method used at all.

4.04. The diagnostic procedure that has just been described also cuts across the characteristic of sameness of structural meaning, as previously observed. A Class 1 word, for example, in modifier position, will surely not have the same structural meaning as one in head position. But it is still found as Class 1. (1952, Chapter X.) (Possibly this is because it will not fit both diagnostic positions for Class 3, although a $v + n$ form will fit both frames for Class 3, and is still treated as a Class 2 word in the modifier frame.)

That no one structural meaning is in fact correlated with a single part of speech is evident from various examples. Consider all the Class 3 words listed (1952, p. 83, footnote 15) and the Class 4 words in frame C (1952, p. 84). The traditional but vague notions of noun and verb modifiers seem the only possibilities. But it can be noted that Fries himself describes variations of meaning for words in modifier and other positions (1952, p. 203).

Even if the view is taken that the structural meanings in the diagnostic positions alone are important, while the rest are to be considered of minor value, it is clear that varying meanings are permitted in the one class. Test positions in the diagnostic frames provide different structural meanings regardless of what happens in expanded sentence structures. The position of Class 1 before a transitive verb, for example, cannot be said to have the same meaning as the position after.

Fries is well aware that a position will vary as to structural meaning, for instance in his theory of diversity of strike, and does recognize that different inflectional form classes used in the same positions will provide different structural meanings. But he has failed to make such recognitions in presenting the use of diagnostic positions. Thus the whole method is inconsistent, and fails to satisfy his requirements. (1952, p. 8, footnote 6, p. 79, footnote 13.)

4.05. In summary then, we have not been able to find that a formal and not an arbitrary procedure has been followed. Certain positions, along with their structural meanings have been picked out in preference to others for an unstated reason. Same

sets of positions and same structural meaning in all positions have both been discarded. This could be due to traditional meaning assumptions, or it could be based upon statistical studies of occurrence, or could be allied with the occurrence of certain ranges of inflections.

It will be seen that the given positional analysis is in fact made subsidiary to a primary inflectional classification.

5.0. THE OPPOSITION OF INFLECTIONAL AND POSITIONAL CHARACTERISTICS

5.01. It will be convenient now to amplify previous remarks concerning this heading, and to enquire how much Fries holds the study of bound form inflectional occurrence to be important in the initial establishment of the parts of speech.

We may begin by taking some quotations from Chapter V. We may then proceed to deal with other groups of remarks.

(A) " It is not enough for our purpose to say that a Class 1 word is any word that can fill certain positions in the structure of our sentences, even if we enumerate all these positions. We want to know what the special characteristics of these words are that make them recognizably different from the words used in other positions." (1952, p. 79.)

Again : " In Chapter VII we shall enumerate and describe the various contrasts which we have found to mark the parts of speech in English. In the rest of this chapter we shall sketch the procedure used here in the attempt to discover inductively from the recorded materials what these various contrasts were." (1952, p. 74.)

Apparently then, the main use of inflectional studies is in description of classes already established by positional means.

(B) However, remarks made later in the book tend to modify this point of view. The first occurs in a summary remark upon the identification of function words. The procedure here employed for this was the same as in the chapter for the setting up of parts of speech.

" In both we took from our materials single free utterances as test frames and, by the process of substitution, tried to find the words which, with the marks they had in their original utterances, could be used in the test frames without a change in the structural meaning." (1952, p. 104.)

It is a little disturbing to find this statement some time after the method of analysis by positions has been presented. It may be seen that an attempt is made here to show that both bound forms and free forms mark out the same classes. We assume that " the marks " include inflections, and find that the claim will unite into one class some words which Fries treats in separate classes. For example, $v+n$, $a+o$, $n+o$ may be taken from their original occurrences and found to fit the diagnostic frame *The — n+o*. We may also find that at least one class which Fries recognizes, has members which do not satisfy the claim. For example, if *boy's* which occurs in *The boy's hats* is placed in frame B for Class 1, it will be found that it cannot occur here, although it is a word which belongs to Class 1. (1952, p. 118.)

The second attempt to show that both inflections and positions have the same diagnostic value is made a little later:

"Our procedure for finding these identifying characteristics was a study of the contrasts between the forms of the items in our lists for each of the four classes *in the frames by which they were tested*. This examination gave us not only contrasts in the forms themselves but also contrasts in the *formal marks of the various* 'positions' in which each of the classes could appear. Our identifying characteristics, therefore, are of both kinds. We are not concerned here with classifying words in isolation but solely with these items as they occur in live utterances carrying on conversations—with the practical functioning of language." (1952, pp. 111 - 12.)

Now it has already been maintained that such a general practice can only hold if a single structural meaning is established for each part of speech, because inflections and positions may mark out different classes of words. Words capable of using entirely different inflectional sets will appear in the same free form frames. For example,

The fireman catches ^{up} *quickly* _{children} *,* shows a set of words which may occupy the same

positions but which are not ever capable of all using the same inflections. Failure to recognize this is repeated.

The important feature of the last quotation is the statement that words are not to be classed in isolation from their positional uses, by taking account only of contrasts in the forms of the words themselves. (Compare 1952, pp. 139 - 140.)

(C) In other places this appears to be modified, if not contradicted, and indeed, it will be found that the following set of references is at odds with the tenor of the previous two quotations. Here we find a major tendency to rely on bound forms alone as the means of distinguishing word classes. The remarks occur in the description of classes already established by positional means, and have not been used by Fries in presenting methods of analysis, but nevertheless show a recognition of the diagnostic importance of bound forms.

Consider various comments (1952, pp. 122, 126, 132) which together with his listing of defining characteristics in the same chapter, make it obvious that words are classified in isolation. Indeed, it is twice really said that positions are less significant (1952, pp. 122 and 132). Again, in this chapter, Fries points out that Classes 3 and 4 can occupy the same diagnostic frame and be differentiated only by study of the forms of the words.

5.02. If (A), (B), and (C) are compared, it is easily seen that the theoretical diagnostic value of inflections and other bound forms is quite obscure. Despite the theory that parts of speech are defined by finding words with the same set of positions and with the same structural meaning, the actual description of the characteristics of the classes continually suggests that this is inadequate. Fries alternates between the use of position and the use of inflection and this cannot be explained by any

theory of diversity of strike, that some one structural meaning enables such a fluctuation to happen.

For instance, although he makes the rule that when positions and other markers conflict, the positional markers are in general to take precedence (1952, pp. 112 - 13. 141), and although he follows this out in some cases (1952, footnotes pp. 118, 125), there are many in which he does not. It is the aim now to show that in actual practice the method by which the four parts of speech have been set up has been primarily through analysis of inflections. (Here, too, an inflectional range, or any list of bound forms as in Chapter VII, need not mark out a single structural meaning. Eg. $+s$ and $+ism$ mark out Class 1 in Chapter VII.)

5.03. Firstly, even in the diagnostic frames it is evident that some words which are given the same class head, will fit one frame but not another. What is it that enables them to be brought together in such a way ? A similar question may be asked concerning ' structures ' when we read:

" ... the names ' subject ', ' predicative nominative ', ' appositive ', ' direct object ', ' indirect object ', ' object complement ', ' adverbial object ', ' noun adjunct ' are the names of structures in which Class 1 words appear. (1952, p. 201.)

Again, what is it that puts a limit on the positions a word of a class may occupy, and the meanings it may use ?

Fries might agree that the estimates of the positional occurrences of words are only of an introductory kind. But it may be added that the choice of certain positions as diagnostic leads to oversight in recording the diversity of positions in which a word may occur. If we are going to find parts of speech by listing the words which appear in the same set of positions, then it is necessary, for example, to recognize the group of words which appear in both Class 1 and Class 2 positions. The use of words with the past tense inflection, or of words which in the present cannot also be used as Class 1, in the test frames for Class 2 (1952, pp. 80 - 1), tends to make us forget this feature of English. For example, a word like " run " may occur not only in frame C for Class 2, but in frames A and B for Class 1 as well.

It may be held that Fries is not really attempting to set up lists of words, but to establish structural meaning units which may show the use of the same words in different ways. This may be true in some places (e.g. 1952, pp. 62, 118), but it is not his stated practice when he discusses the use of test frames.

5.04. Some clear examples of the classification of words according to inflection may now be given by discussing features of the four parts of speech themselves. (Chapter X is important here.) A reading will show that there is a realization that words with different endings will enter the same positions and that when this occurs inflection becomes the obvious means of class identification. (For example, 1952, pp. 208, 218, 231.)

" The ' modification ' structures with Class 1 words as heads may be formed of any of the four parts of speech or all of them together." (1952, p. 210.) Such a statement permits words which enter this and the second diagnostic position for Class 3, to retain their class names according to their inflectional characteristics.

We can find that such words as the following in the diagnostic frame A position for Class 3 can frequently occur:

Frame A sequences: *hospital gardens*
                          elephant zoo
                          rich workers
                          gas lights, etc., etc.

There is no marker evident here which enables us to separate *elephant* and *gas* from *rich,* and there is no reason provided in the book why we should. Yet practices in Chapter X make it evident that we ought to do so. Is 'rich' to be separated because of its use in positions which the other words will not enter ? In that case, it would seem that the theory of diversity of strike, with its insistence that units of structural meaning have varying formal patterns, would have to be discarded.

There is neither a positional nor a meaning reason why 'rich' should be called Class 3 and the other two words Class 1, for these last, like other words, will also appear after the verb in frame B.

He was elephant enough to break it.
It was gas.
Charity is love.
Her name is dirt.
Their bones are dust.
The fair was fun.
He was friend and enemy both.
Language is thought.
His words were law.
One virtue is faith.

Inflections alone remain to differentiate *rich* from the other two words. The same applies when a word with the inflection +'s appears in the diagnostic frames for Class 3 but is still called Class 1. (It may be remarked that $n+$'s is also oddly considered a group A word. (1952, p. 89).)

The conclusion also applies when words such as *injured, clean, worn* (which occur in Class 2 positions) appear in the modifier frame for Class 3. Because of their 'modifier' meaning and positional characteristics, words of this kind should no longer be considered Class 2 at all. (Contrast 1952, p. 208.) It is of interest, again, that although words of Classes 1, 2 and 3 may all appear in the one meaning and positional unit, each is differentiated from the other.

Turning now to Class 4, we may note that the naming of its members is said to depend on the ability of words to fill a position before or after the verb in order to modify it, as well as the position before a Class 3 word, where the words also have some sort of modification meaning. They may also occupy some other positions. Consequently, they appear to have a number of structural meanings.

Now all these features seem to be permitted, because the Class 4 words, except for a few, are always characterized by +*ly*. (See 1952, pp. 235, 228.) For those

which are not, the reason why they are considered Class 4 is not at all clear. Again, how Class 3 is separated from Class 4 is not explained in examples. (1952, pp. 135 - 6.)

It is true that Fries is aware that there are unsolved problems concerning Class 4 (1952, p. 227, footnote 18), but we may link the tendency to confusion with the following general assessment. Neither position, nor meaning, nor even inflection at times, can consistently tell us what part of speech a word belongs to, even though there is an inclination towards an acceptance of inflection.

For a final example of incoherent practice, it can be seen that not only Class 1 words will appear after group F (1952, p. 119), but members of other groups and classes will do so as well. How are we to tell that the words after the Group F value are or are not Class 1 ? For example, when a word appears after the sequence consisting of a member of Class 2 followed by a member of group F, how are we to tell whether it is Class 1, 3 or 4, for all these classes will appear in these circumstances. When there are no inflectional marks existing on such a word, we cannot try to find a positional answer, since words of the three classes will also enter more than the picked sets of positions ascribed to each class as defining characteristics.

Again, how do we know that the structural meaning of the position after F is to belong to any particular class, especially if it is one that is different from any previously ascribed to a class. When we come to cases like *the men at fault, the men on high, by air, by committee,* we do not know whether the last words are Class 1 or Class 3, *unless* we consider what ranges of inflections they are capable of taking in any other circumstances.

6.0. DIVERSITY OF STRIKE AND PARTS OF SPEECH

6.01. It is difficult to understand what exactly ' a part of speech ' means in Fries's system of analysis. On the one hand it is treated as a unit of structural meaning characterized by varied patterns of formal markers satisfying the theory of diversity of strike, and on the other as a class of words all isolated by their regular use of certain formal features. We have just seen instances of the last case.

The confusion created by the attempt to deal with a part of speech in both ways underlies problems we have previously dealt with, and results in failure in the chapters on the classes to present useful procedures. For example, in frame A for Class 1, a structural meaning unit is marked out by the appearance of a certain group of inflections in the positional frame before the verb. But at the same time a class of words is created which may not only have this particular positional marker (and range of inflections) but others as well. Some of the words which can occur here can also occur in the verb position or after the verb. Consequently, finding the devices that signal structural meaning is not kept clear as a single activity.

The word class/single structural meaning opposition contrasts with Fries's claim that there is no characteristic *except* structural meaning which members of a class have in common. (1952, pp. 64, 73.) The parts of speech are said to exhibit a

certain range of formal features which are used selectively according to the pattern, i.e. the functional or structural meaning unit in which their members occur. This is the theory of diversity of strike (1952, pp. 59 - 61. See also p. 141.)

The same set of positions theory (1952, pp. 64, 74, 75, footnote 8, various footnotes giving lists of class words, etc.) is thus clearly invalidated along with the theory described in 2.0 above.

This last maintains that parts of speech do not treat words as separate morphological form classes, but that " Our words *with particular markings within an utterance* become the significant members of structural patterns, each of which signals a structural meaning." (1952, p. 141.)

6.02. Such a remark leads into a second type of contradiction. For despite the suggestion that words are not to be classified in isolation from structures, it has been seen in the last section that there is a considerable dependence upon inflectional characteristics, and that this does not consider the positions in which words occur.

Thus the use of both free forms and bound forms indicates in actual practice, a habit of listing words regardless of single units of meaning, and in isolation from units of function with required patterns of formal features. Traditional meaning selections are evident. For example $v+d$, $n+$'s and $n+o$ retain their class names in a variety of different meaning structures. Thus *boy* in *the boy's hats* is treated by Fries as Class 1, even though it is different in meaning from *boy* as Class 1 in *The boy hit the ball,* and occupies the same position as many other words in *the — room* (1952, p. 118). A strict classification of formal features according to a single structural meaning would have to re-classify bound forms under different heads from those given in Chapter VII.

Some practice like the one Fries actually and arbitrarily uses, or the one suggested, is absolutely necessary to replace the invalid fabrication of the system. If more than one meaning is permitted for a part of speech in Fries's theory, then there is nothing left by which to define a class at all.

6.03. Clarity could be gained by selecting certain positions and meanings and disregarding the rest. This would eliminate remarks about words having the same ' shape ' in different positions, because the ' shapes ' would then just become words with varying formal uses, to be classified accordingly—e.g. n/a, v/n, etc. " These markers (i.e. free form function word markers) identify the functioning form-class of those words that have the same shape in two or more parts of speech." (1952, p. 118. See also pp. 111 - 12.) A part of speech in this sense is quite different from a part of speech which, in Fries's theory, should be established by seeking words which occupy the same set of positions.

However, although Fries may recognize well enough the differences of meaning in different positions, discussion of contradictions can be concluded with an example of failure to see that positional and meaning analysis cannot be combined.

" In the preceding two chapters . . . [we have tried] to classify the words of [our] materials in functioning units—in parts of speech. In that attempt we have assumed that all words that could occupy the same ' set of positions ' in our

utterances belong to the same part of speech." (1952, p. 110. See also pp. 74, 110 - 111, 139 - 141.)

6.04. Our explanation of just what Fries was trying to do with the theory of diversity of strike has been given. He tried to deal with the fact that words with the characteristic inflections of one class may enter the positional frames of another. Slipping between a study of the positional frames and the morphological features of words, he tried to overcome their opposition to one another by establishing functional units, or structural patterns, whose formal markers are diverse.

As a result, the previous sections of this paper have shown the theory to allow the characteristics of the classes to fluctuate in an arbitrary fashion. For example, how are we to tell the limits of formal variation in a test frame ? Practice (1952, pp. 78 - 9) may show that structural meaning is altered, but theory (1952, p. 79, p. 75, footnote 13) says that it should not be.

The analysis of a single position as a marker of a particular structural meaning is confused with the analysis of classes of words which can occupy a number of positions and have certain ranges of bound forms. The attempt to establish different units of structural meaning as characterized by formal markers of free and bound forms in various patterns, contrasts with the analysis of positional and bound form similarities in order to denote a class of words, not a feature of structure with a single structural meaning.

6.05. The solution to the series of difficulties which have been examined in this paper, reduces to separating the use of bound and of free form characteristics as markers of English grammatical features. Firstly, the full inflectional range may serve to establish classes of words with constantly definitive characteristics. Then the positions which one or more of these parts of speech can enter may be stated separately. A re-definition of the classes can follow if required, but cannot be confused with the first procedure.

What structural meaning or meanings each position has when filled by one of the word classes may then be studied finally. A system like this would dispense with the theory of diversity of strike, and re-present the material that Fries handles in a rather different manner.

7.0. CONCLUSION

7.01. A short summary of inconsistencies among the criteria used by Fries for finding and describing the parts of speech may be convenient.

It has been seen that:

(a) The theory of selecting words according to the same set of positions which they occupy contrasts with the selection of a limited number of frames, combined with their meanings, as diagnostic for a class.

(b) Neither of these features satisfies the insistence on a sameness of structural meaning for a part of speech.

(c) Nor does the use of inflectional characteristics in conjunction with any positional features, link with a sameness of structural meaning. Consequently the theory of diversity of strike fails, because its primary feature, a single structural meaning unit, is absent. One unique diagnostic positional meaning (or perhaps more) as the defining feature of a part of speech, becomes overlaid by the acceptance of various meanings.

(d) The classification of words according to their inflectional ranges contrasts with their grouping according to either selected diagnostic positions, or to the complete range of positions which the words may enter.

(e) The treatment of a part of speech as a class of words with consistent features but varying meaning values, contrasts with the treatment of it as a single meaning or functional unit which more than one class of words can enter. The term " part of speech " describes the results of two different activities.

(f) The actual means by which the word classes are established, depends largely upon study of their inflectional ranges. This contrasts with the descriptions of the methods used initially to find the parts of speech. It also enables us to recognize word classes despite the confusing criteria, and the variable uses of meaning, position, or inflection as markers of a class.

(g) The assumptions about units of structural meaning apparently link with traditional assumptions about the classes of specific inflectional ranges, but show an arbitrariness in their selection. They also seem to have provided a means by which diagnostic frames were selected, for these are not always definitive of one inflectional class. This contrasts with Fries's view that he proceeds from form to meaning (1952, p. 57, p. 203) and not meaning to form.

7.02. Answers to these inconsistencies have been suggested. However, the formal oppositions could be permitted if a part of speech were a single meaning unit, consequently able to link together varied patternings of bound and free forms. Nevertheless, we have seen a number of difficulties in beginning syntactic analysis through meaning and not form. It may also be remembered that the theory of diversity of strike does make an attempt to handle the variety of sequences which bound form classes may enter. (See 1952, pp. 62, 111 - 12, 118.) The view that word classes defined by inflections may be given their rules as to positional occurrence in any of the patterns of classes and constants in each of the sentences p 1 . . . n, may be treated as a clarification of it.

It is true that, under certain conditions, both positional and inflectional characteristics may be allied in order to define word classes. The positions in various sentence sequences which permit only one inflectional class to enter, could also be used to define the class, even though its members could appear in other positions which allow the entry of members of other classes. We could apply to their occurrence in these last circumstances, a test as to whether they will appear also in the uniquely diagnostic test frames. It is unfortunate that Fries's diagnostic positions do not always characterize uniquely the bound form classes he establishes.

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A PRELIMINARY INVESTIGATION OF CERTAIN ASPECTS

OF INTONATION

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Intonation is the linguistic form in which the speaker organizes certain kinds of information. It is well-known that intonation is related to the fundamental frequency pattern of the speech wave, but it must also be related to changes along other acoustic dimensions because the intonation " tones " are still recognisable in whispered speech. The fundamental frequency, intensity, spectrum and duration changes associated with six intonation " tones " were investigated. The need for further work of this kind was indicated. The relation of acoustic variables and intonation was further investigated by using speech synthesis. Syllables with the same spectrum and intensity were generated in which the fundamental frequencies were controlled by the intensity variations of humanly-produced syllables spoken on six different intonation " tones ". The test established that the synthesized syllables conveyed some of the information about the intonation of the humanly-produced syllables. Methods for carrying out experiments on intonation with phonetically untrained subjects were investigated. The need for further experiments using methods of speech analysis and synthesis along lines indicated is pointed out. The importance for analysis-synthesis telephony of more extensive knowledge about intonation is discussed in some detail.

INTRODUCTION

For many years now research in acoustic phonetics has been centred on finding the acoustic correlates of phonemes. The phoneme sequence, however, is not the only linguistic form in which information to be transmitted by speech is organized: factors like intonation, stress and rhythm also make their contribution. Recognition of these factors will not only provide the listener with additional information about the speaker's intentions, but, because they help to indicate the speaker's line of thought they will also affect phoneme recognition.

Intonation is the linguistic form which conveys information about the speaker's emotional attitudes to the subject-matter, attitudes such as doubt, agreement, questioning, affirmation, continuing interest, etc. The " tones " of an intonation pattern must, then, be considered as existing entirely in the linguistic domain and as constituting elements of language in the same way as phonemes or words. Nevertheless, intonation is often considered to be identical with the pattern of fundamental frequency, or larynx frequency, variation of the speech wave. In fact, the relationship

is only a statistical one, that is, there is a certain probability that a given tone is represented by a particular frequency pattern. This relation is analogous to that which exists between phonemes and particular acoustic patterns: a phoneme is often related to a particular acoustic pattern but at other times it is associated with a different acoustic pattern which in turn in other contexts may be associated with another phoneme.

Not only do phonemes, intonation tones and all other linguistic units have only a statistical relationship with particular acoustic characteristics, but also any one linguistic unit may well be correlated with events along several acoustic dimensions. For example, it is well known that phonemes are associated with particular patterns of acoustic spectrum and therefore it is often believed that spectral patterns are the only kind of acoustic characteristic that contribute to phonemic identification. This however is not true and an example of this has been demonstrated by an investigation which showed that certain phonemic distinctions depend on the duration of acoustic events rather than on their spectrum (Denes, 1955). Again, stress—a linguistic element—is often characterized by intensity changes of the sound wave and is often considered to be identical with it. It has been demonstrated however that duration and also fundamental frequency can serve as cues for the recognition of stress (Fry, 1958). In the same way, although intonation patterns are often associated with particular changes of fundamental frequency, it is still possible that variation of other acoustic characteristics, perhaps of intensity, duration or of spectrum, may also serve as cues for the recognition of intonation.

A simple indication of whether acoustic factors other than fundamental frequency play a part at all in the recognition of intonation is provided by whispered speech. There is no vocal cord vibration in whispered speech and therefore no fundamental frequency; nevertheless, it is often thought that the speaker is able to convey to the listener much of the information that is normally considered to be contained in the form of intonation. A few simple qualitative experiments were carried out to test this, and they indicated that much of the information normally organized as intonation, such as the differences between affirmation, question, emphatic statement, reservation, doubt, etc. was in fact retained in whispered speech. Some further purely qualitative experiments were then carried out with a vocoder. A vocoder is an analysis-synthesis telephone system in which a simplified version of the speech wave is transmitted. The output consists of a sound wave with a spectrum that in broad outline corresponds with the spectrum of the speech wave produced by the speaker. This spectral pattern can be excited at will with a periodic or a noise source, producing either voiced speech or whisper, and, when present, the fundamental frequency of the output can be controlled separately.

In these first experiments the vocoder was used in the following ways:
1. The output was permanently switched to whisper.
2. The output was permanently switched to voiced speech, with the fundamental frequency kept constant, producing monotone speech.

3. The output was permanently switched to voiced speech with the fundamental frequency varied according to some arbitrarily determined patterns. For instance, the speech input consisted of a word pronounced on a falling intonation and the pattern of fundamental frequency variation of the output was given a rising or a rising-falling pattern.

Generally speaking, the input consisted of words in isolation, although some sentences were also used. The words were pronounced by expert phoneticians on a number of different tones, i.e. high fall, low fall, high rise, low rise, fall-rise and rise-fall. The corresponding output of the vocoder, which was adjusted in turn to all three conditions outlined above, was then interpreted by a few listeners.

Only phonetically-trained listeners were used in this experiment as it was intended only to serve as a guide for establishing a proper line of investigation. Later on considerable thought was given to the questions that can be asked of phonetically untrained listeners in order to find out if they have received information associated with intonation. A method for this is being evolved and some discussion of the problem will be found later in this paper.

The first vocoder experiments showed that listeners had little difficulty in distinguishing the intonation " tones " when the vocoder was switched to whisper. The intonation was largely lost when monotone was used and the experiment was inconclusive when the fundamental frequency pattern of the output was varied arbitrarily.

Recognition of the intonation pattern with the vocoder switched to whisper indicates that information about intonation is present in the speech wave not only in the form of fundamental frequency but also in terms of other acoustic characteristics, which are maintained when the fundamental frequency and its harmonics are eliminated. These cues are masked, as shown by the experiments with the vocoder switched to " voice ", by an arbitrarily imposed fundamental frequency ; monotone is just one example of an arbitrary fundamental frequency pattern and impedes the recognition of intonation as compared with whisper.

The possibility of finding some acoustic characteristics other than fundamental frequency that are related to intonation may well prove important for analysis-synthesis telephone systems. There are a number of such systems—the vocoder is one example—which transmit a simplified version of the spectral pattern of the speech wave in a more or less satisfactory manner. On the other hand, there is as yet no economical and efficient way of extracting and transmitting information about the fundamental frequency pattern of the speech input. Therefore the sounds synthesized at the receiving end of such telephone systems will either have no fundamental frequency or one which does not follow the fundamental frequency of the input sufficiently accurately for satisfactory speech recognition. In the former case the output will appear as whisper, which is not acceptable to most listeners, although it might contain quite a lot of information about intonation. In the case of a voiced output, the presence of the wrong fundamental frequency will mask the intonation and the same applies, of course, if, in order to avoid having the output in the form of whisper, a

neutral fundamental frequency pattern or a monotone is imposed on the output. In fact, it seems that if the output of these analysis-synthesis telephones is to be acceptable, they must be produced with the fundamental frequency pattern appropriate to the intonations used by the speaker. This could perhaps be achieved, despite the difficulties of detecting the fundamental frequency, if some other acoustic correlate of intonation could be found which is easier to detect than the fundamental frequency. This acoustic characteristic could then be transmitted and used to control the fundamental frequency of the synthesized output in a manner appropriate to the intonation " tone " being transmitted. The realisation of such a system would require detailed information, not only about the relationship of intonation with a suitable acoustic characteristic but also with fundamental frequency.

At the moment all that is known about this latter correlation is that intonation tones are associated with certain kinds of fundamental frequency change. It is not known however what the scatter of this relationship is either in the frequency or in the time dimension ; in other words, it is not known how accurately the fundamental frequency of the sound heard by the listener has to follow the pattern of changes in the sound produced by the speaker in order to bring about satisfactory recognition of intonation. Even if more successful methods for measuring the fundamental frequency of speech waves were available, more detailed information on these last points would still be required so that the performance specification of the devices for extracting and transmitting the fundamental frequency could be drawn up.

INVESTIGATIONS USING SPEECH WAVE ANALYSIS

In the light of these considerations, it was decided to investigate the relationship of intonation with as many different kinds of acoustic characteristic as possible and the rest of this paper will describe our preliminary experiments. Their purpose was to find in what directions future experiments are to be planned and to size up any new techniques that may be required rather than to obtain exhaustive or strictly quantitative results. Some of these experiments were in the field of speech analysis and others used speech synthesis. The analytical experiments were concerned with measuring the changes that occur in the acoustic characteristics of the speech wave when the various "tones" of intonation are spoken. The aim of the synthesis experiments was to see the kind of intonations recognized by listeners when they hear synthetic sounds generated according to various pre-determined patterns.

First of all a list of meaningless syllables was made up. Some of these consisted of isolated vowels such as /a/ and /i/ and others of consonant-vowel or vowel-consonant sequences like /na/, /ni/, /an/, /in/ etc. It was realised, of course, that the intonations of linguistic units of greater length, such as words and sentences, are all of interest. These would have to be investigated separately and as a start isolated phonemes and meaningless syllables were tried because they were the simplest possible units. The vowels and the consonants were chosen to provide as wide a

range of articulation as possible. The vowels /a/ and /i/ were chosen as examples of open and close vowels; in addition the diphthong /ai/ was also used. Two consonants were chosen: one a continuous one, /n/, and the other a plosive, /t/. The three vowels were used in isolation and also in combination with the two consonants to form the CV and VC syllables, as has already been indicated. These syllables were pronounced by three different speakers. Each syllable was pronounced in isolation, six times in succession, each time using a different intonation "tone". The tones used were low fall, high fall, low rise, high rise, rise-fall and fall-rise. All three speakers were highly-trained phonetically, providing reasonable certainty that despite the frequency type labels attached to these tones they produced these syllables in the manner of normal speakers when they intend to transmit the kind of information associated with the above six categories of intonation. These syllables were recorded on tape and formed the basis of the analysis and of the synthesis type of experiments.

The sound waves were first analysed in a variety of ways. The fundamental frequency, the intensity and the spectrum were measured and their variations were plotted against time. The duration of each syllable was also measured.

The fundamental frequency was measured by applying the output of the tape, after low-pass filtering, to the coil of a pen-recorder. The highest fundamental frequency of interest was about 300 c.p.s. but the pen only responded up to about 100 c.p.s. The tape was therefore played back at a quarter of the recording speed, bringing the highest fundamental frequencies just below the upper limit of response of the pen. The pen responded to the fundamental and a few of the lower harmonics and the recording showed the duration of each larynx pulse. These durations were measured, the data were converted into frequency and plotted against time.

The intensity was measured by applying the tape output to a conventional rectifier and integrating circuit measuring mean voltage, and its output was again applied to the pen-recorder. The line recorded in this way gave the intensity-time graph directly.

The spectrum was measured by using the Kay Sonagraph. The wide band type of adjustment was used because the movements of the formants rather than of the individual harmonics were of interest.

The fundamental frequency tracings, although they have not yet been fully analysed, show clearly that in some cases the frequency changes follow a simple pattern: a straightforward fall in frequency for a falling "tone" (Fig. 1a), or a simple rise in frequency for a rising intonation "tone" (Fig. 1b, c, d) and examples of this could be found among the syllables consisting of vowels in isolation as well as among the VC and CV syllables.

Although this simple relationship between intonation and fundamental frequency could be seen in some of the syllables, there were numerous examples where these simple patterns, although still present, occurred in combination with important modifications. The most important of these was a marked tendency for the fundamental frequency to start at some middle value, whatever the rest of the frequency
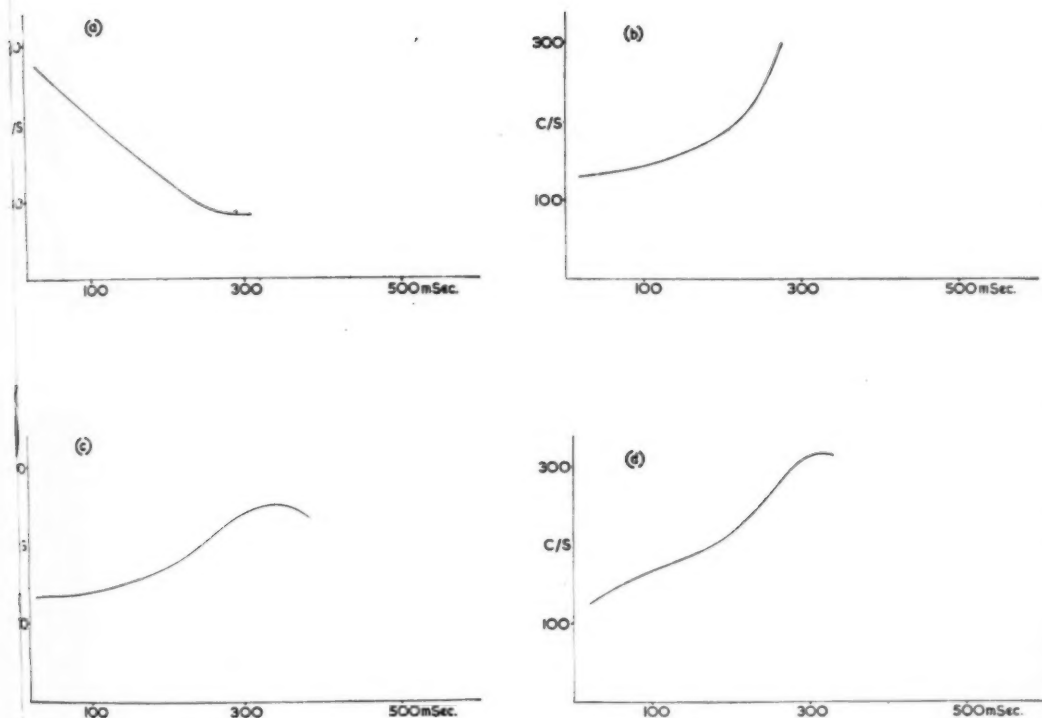
Fig. 1

pattern was. Fig. 2a shows an example of this, where the frequency change for a falling tone is represented. The characteristic fall in the fundamental frequency can be seen clearly, but it is preceded by a rise during the first 60 msec. Fig. 2b shows a similar case where the initial falling part of a fall-rise pattern is preceded by a frequency rise during the first 150 msecs. and Fig. 2c shows this effect for a low rise " tone ". This tendency is even more pronounced when the syllable has an initial or final voiced consonant. In such cases there is a marked tendency for the characteristic

change of fundamental frequency to be confined to the vowel part of the syllable. In other words, the frequency fall for a falling " tone " or the frequency rise for a rising " tone " takes place largely on the vowel part and the frequency tends to take up some middle value during the consonantal segment. Fig. 3a relates to a /ni/ syllable pronounced on a high fall " tone ". The lower value of the frequency during the first 100 msecs. shows the effect of the initial consonant. Fig. 3a should be compared with Fig. 1a which relates to an /i/ syllable pronounced by the same speaker on the same tone. Comparison of Figs. 1a and 3b, relating to syllables /i/ and /in/, both pronounced on a high fall " tone " by the same speaker, shows the same effect for a final consonant. The tendency of initial or final consonants to be pronounced at a middle frequency whatever the intonation " tone " is also shown in Figs. 4a, b, c, which show the frequency pattern of the syllables /ai/, /ain/ and /nai/ pronounced by the same speaker on a rise-fall " tone ".

All the graphs are drawn as smooth curves ignoring small variations of frequency. In fact there are often small fluctuations and sometimes quite large ones at the beginning of syllables, probably indicating the correcting action of acoustic feed-back.

As already mentioned, the data have not yet been fully evaluated, but it is obvious that the relationship is not quite as simple as is sometimes imagined. Full evaluation of these and other data on syllables and later sentences should give valuable information about the rules relating fundamental frequency and intonation. Such results will also serve as guides for further experiments to determine the fundamental frequency pattern tolerance for the recognition of intonation.

The intensity of the speech wave was also measured and plotted against time. On inspecting these intensity graphs, it became obvious that on many occasions the shape of the intensity-time curves was similar to the fundamental frequency-time curves. Fig. 5 shows the results for the syllable /a/ pronounced by the same speaker on all six " tones " used in the experiment. The frequency and intensity curves for each " tone " are shown together. Fig. 6 shows the same for syllable /nai/. It will be seen that for most " tones " fundamental frequency and intensity vary in a similar way. The exception is the high rise " tone " for which the two curves are consistently different. Also, as might be expected, the intensity curves always start and end at zero whilst the frequency can start and end at any value. This latter effect appears quite pronounced in the present results but would probably be less so if speech over longer durations than syllables had been considered.

In the syllables containing more than one phoneme the intensity varied regardless of intonation as the quality of the sound changed from phoneme to phoneme. This was quite to be expected as the varying relationship between the formants must influence the total intensity even if the speech effort remains the same. It is quite possible however that intonation is related to the speech effort rather than to intensity. Experiments are therefore in progress to find some component of the speech wave that is more closely related with speech effort—and not influenced by phonetic quality—than the total intensity as measured up till now.

The spectrum of the syllables was also recorded. Meyer-Eppler (1957) showed that
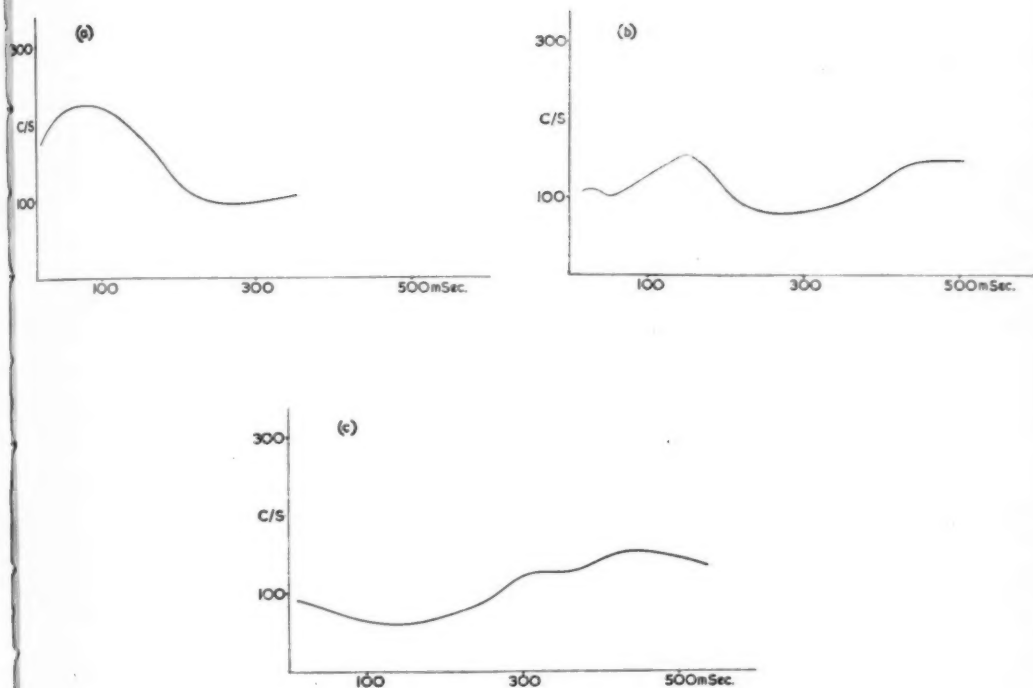
Fig. 2

in whispered speech the third formant is affected by the intonation. In order to get a standard of comparison with the type of speech reported on by Meyer-Eppler, many of the test syllables were repeated in a whisper, again using the same six " tones ". It was found that on many occasions the same results were obtained as those of Meyer-Eppler, that is, the movement of the third formant was related to changes of intonation pattern. These changes were however small and therefore not easy to measure accurately. The changes were much more pronounced with whisper than with voiced speech. Taking the syllable which showed the largest change of third formant frequency as an example—the change being large, it was easier to measure— it was observed that the vowel /a/ whispered on a high rise " tone " showed a third
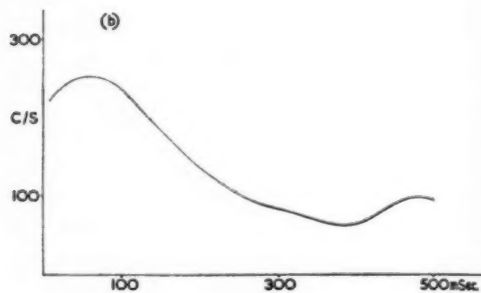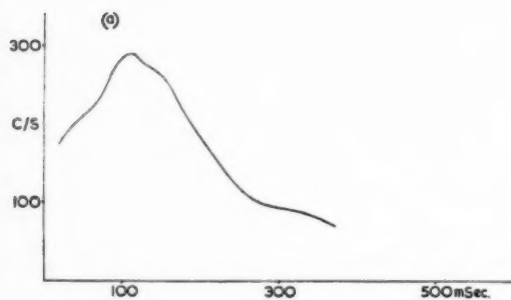
Fig. 3
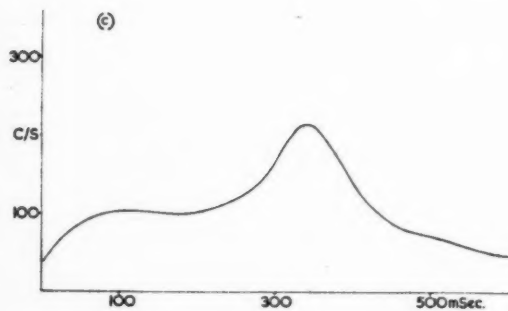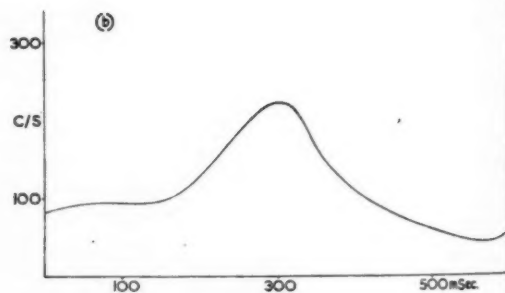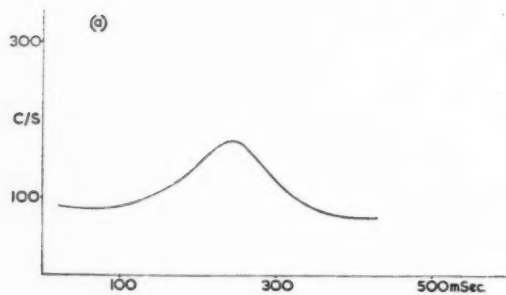
Fig. 4
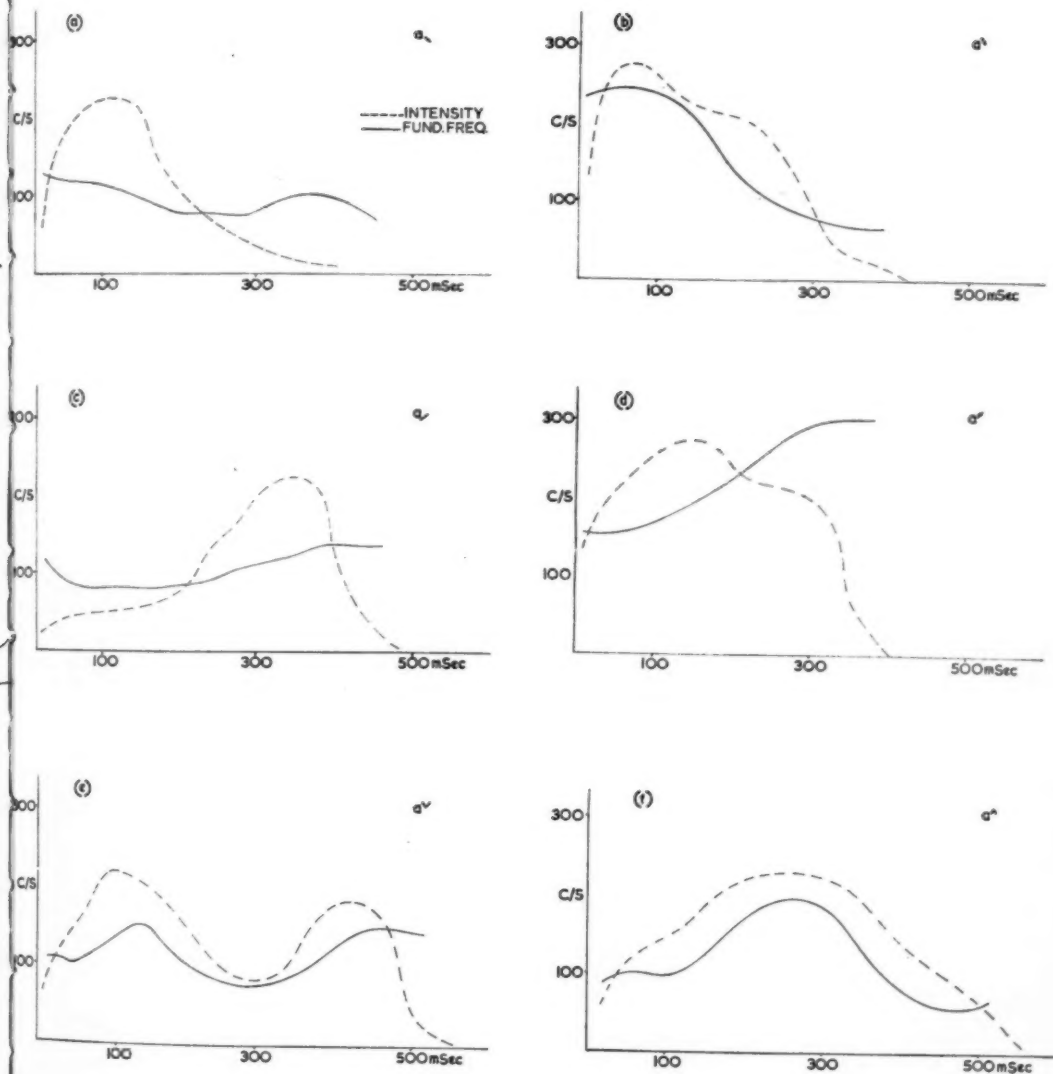
Fig. 5
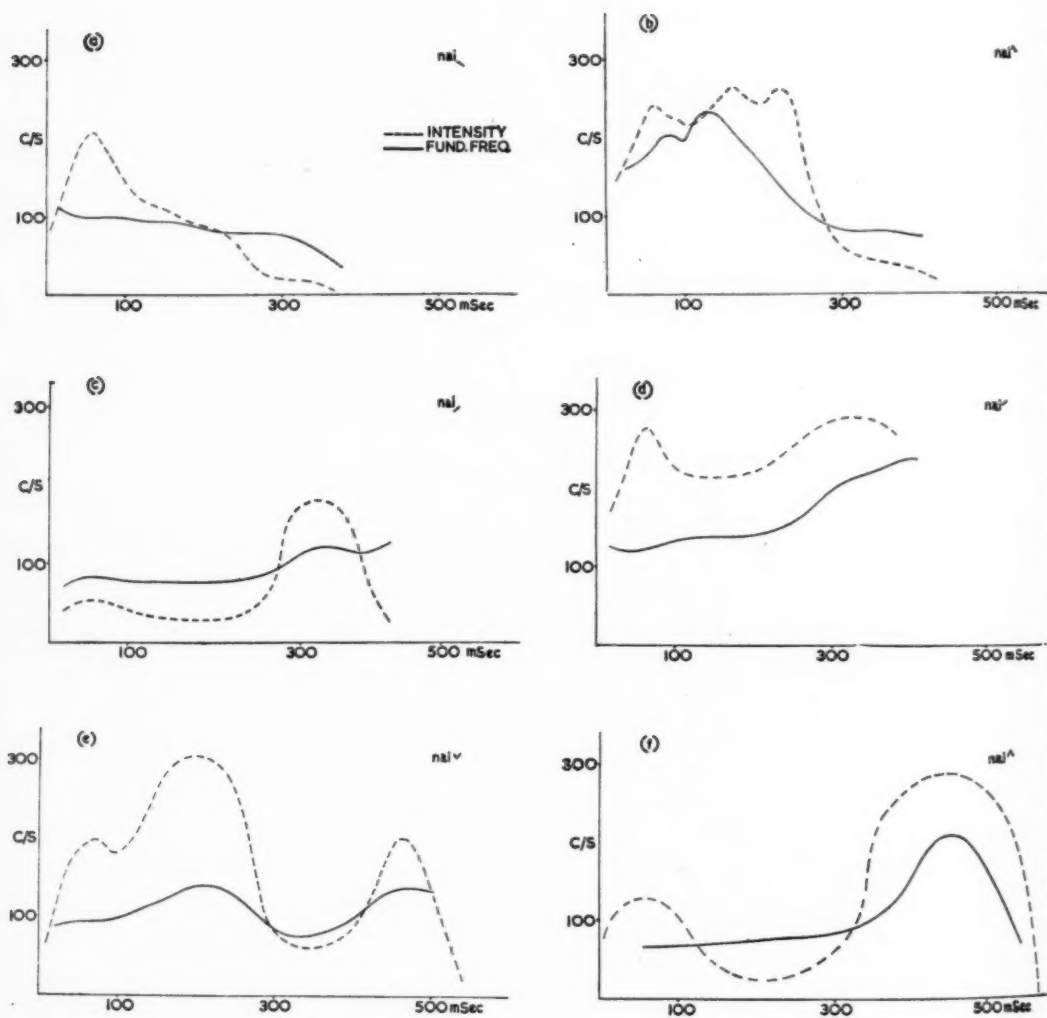
Fig. 6
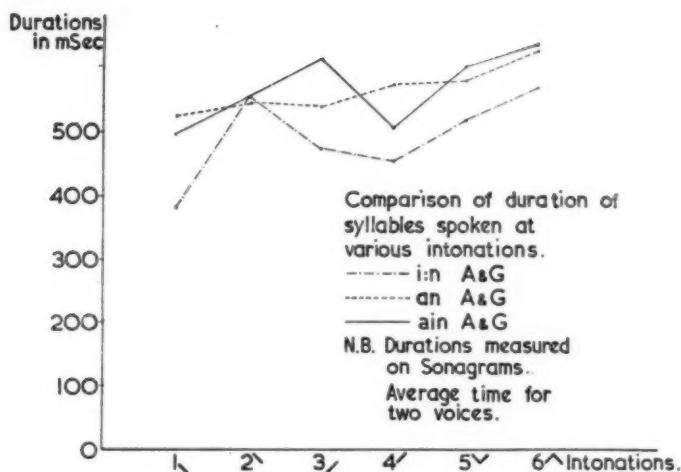
Fig. 7

formant change of over 500 c.p.s. whilst the same syllable produced with voice produced a third formant frequency change of only 250 c.p.s. There were many examples where the third formant remained unaffected by the frequency change. The relationship is an interesting one, however, and merits further investigation.

The duration of each syllable was also measured and some typical results are shown in Fig. 7. It will be seen that the variations are small and there is considerable overlap. Experiments described later in this paper indicated that nevertheless duration does perhaps play a part in the recognition of intonation and should be investigated.

INVESTIGATIONS USING SYNTHESIZED SPEECH

The results just discussed show that for most " tones " the intensity and fundamental frequency of the speech wave vary in a similar way. The extent to which this relationship is significant could be checked by seeing whether the information about intonation is maintained when listening to synthesized speech in which the *fundamental frequency* is controlled by the *intensity* variations of a normal, humanly-produced speech sequence. This would not only throw more light on the nature of the acoustic correlates of intonation but might also provide useful information for the design of the fundamental frequency control of analysis-synthesis telephone systems. It was therefore decided to carry out a few tests in which the humanly-produced syllables

discussed in the previous part of this paper were used to control synthesized syllables. These experiments were designed to serve as a preliminary to the preparation of more extensive experiments.

Two different speech synthesizers, both available at University College London, were used. The spectrum of the sounds generated by each of these machines can be adjusted to produce a variety of different sound qualities and their fundamental frequency can be varied independently according to any law required. In the first of the experiments, the terminal analogue synthesizer described in a previous paper (Arnold, Denes *et al.*, 1958) was used. The spectrum of the sounds synthesized was adjusted to give a quality resembling the sound /i/ and remained the same throughout the experiment. The intensity of the synthesized sound also remained constant. The duration of the synthesized sounds was controlled with a voice-operated switch by the humanly-produced syllables. It would have been better if the duration of the synthesized syllables could have been determined independently. Unfortunately this was not possible but it is hoped that by proper organization the final results can be made independent of its influence.

The intensity of the humanly-produced syllables was measured and was used to control the fundamental frequency of the synthesized sounds. In this way synthetic syllables were obtained which had a spectrum and intensity that were constant and arbitrary and a *fundamental frequency* that varied as the *intensity* of the humanly-produced syllables. A number of subjects were asked to listen to these synthesized syllables to establish whether they could still recognise the intonation of the original syllables that controlled the synthesis of the test syllables. Phonetically untrained subjects were to be used to make the tests more realistic. This immediately raised the problem of how to ask the subjects to write down the intonation " tones " they perceived, as they were not familiar with terms like high fall, fall-rise, etc. The only alternative was to ask them to say what kind of information the inflexion of the sounds conveyed to them and therefore each " tone " had to be given a new label in terms of the information it conveyed. It was not easy to find the most suitable new label for each " tone " and a completely separate experiment was carried out to give guidance in this matter.

In this separate test a group of people were asked to listen to the original humanly-produced syllables, presented in random order. They were told: " The experiment is concerned with the information conveyed by speech, other than the meaning of the words used. The sound sequence of the test words will not mean anything to you, but, just as when listening to a foreign language, although you cannot understand the words you will still be able to follow something of what is being said. For instance, you may be able to tell if the speaker is angry, or if he is giving orders or if he is trying to persuade somebody to accept his point of view. Just write down what meaning you get from the voice inflexions of the speaker of the test words

you will hear ". This was the only help the subjects received and Table 1 shows the actual responses of the first six subjects. The " tones " used when each of the syllables was spoken is shown at the top of each column. It can be seen that the responses given by the subjects agreed with each other to a considerable extent. Based on these responses, a preliminary description of the information conveyed by each of the " tones " was made and is shown in the last row of Table 1.

In the main experiment, the synthesized syllables already described were used, again in random order. The explanation given to the subjects was very similar to the one given in the previous test. They were also told that the sounds they would hear, although speech-like, were produced by a machine. They were handed a list giving the description of the six " tones "—called " categories of meaning " when giving them instructions—as set out at the bottom of Table 1. They were asked to indicate to which category each test word belonged. To clarify matters even further, the test proper was preceded by six words produced by a human speaker, each with a different " tone ", in the same order as the categories shown in the list supplied. At the end of the test, in order to check the correctness of the description of the " tones ", the same subjects were asked to do the previous preliminary test using the humanly-produced

syllables. The results obtained with the synthesized syllables were scored in two different ways. First, the responses of the subjects were compared with the appropriate original " tone ", using the labels shown in Table 1. The second method of scoring consisted in comparing the subjects' responses to the synthesized syllables with the responses they gave to the corresponding humanly produced syllables. It was hoped that in this way any errors in the description of the meaning of the various " tones " could be eliminated, because a subject's judgment of the meaning of a synthesized syllable would now be compared with the subject's own interpretation of the meaning of the corresponding humanly produced syllables.

As an example of the two methods of scoring, consider a synthesized syllable based on a fall-rise " tone ", classified as Category 5 in the list given to the subjects. If the subject classified this syllable as Category 3, then his response was scored as a mistake by the first of the scoring methods. The description of the meaning of Category 3, as can be seen in Table 1, includes " doubt ". Further, assume that the same subject, on hearing a humanly produced syllable on the fall-rise " tone ", describes it as meaning " doubt ". By the second method of scoring, therefore, his response to the synthesized syllable will be marked as correct.

The number of correct responses, expressed as a percentage of the total number of items, was 21% and 56% using the first and the second methods of scoring respectively, showing not only that this particular way of controlling fundamental frequency did help in the recognition of intonation but also that the results based on the second method of scoring were considerably higher than those obtained using the first method. This indicates that the " tone "-labels were not satisfactory. The descriptions were changed to those shown in Table 2, in the light of the responses

TABLE 1

"Tones":	Low fall \	High fall '	Low rise '	High rise '	Fall-rise V	Rise-fall Λ
Subject 1	Factual	Emphatic	Negative answer Doubt	Question	Affirmative answer Agreement Assertive	Incredulous
Subject 2	Statement	Declamatory	Persuasive Querulous	Question		Light-hearted
Subject 3	Thoughtful	Inspiration (idea just occurred) Imperative Emphatic	Requesting	Questioning (surprised, puzzled)	Worried	Satisfied
Subject 4	Positive		Doubt	Question	Definite Understanding	Affable
Subject 5	Confirmation of understanding	Confirmation of surprising information	Interpolation in pause indicating immediate continuation of sequence	Interrogative	Half-hearted agreement	Interested
Subject 6	Confirmatory remark	Emphatic (Yes, you fool)	Doubt (Is it?)	Surprise Interrogative (Really?)	Answer Definite	Grudging affirmative
No of "tone":	1.	2.	3.	4.	5.	6.
First list of descriptions of "tones"	Factual statement Positive confirmation	Emphatic expression	Doubt Persuasion Break in sequence	Question	Definite answer Agreement Understanding	Exclamation denoting interest in continuing conversation

TABLE 2

"Tones":	Low fall	High fall	Low rise	High rise	Fall-rise	Rise-fall
	1.	2.	3.	4.	5.	6.
Amended list of descriptions of "tones"	Factual statement Factual answer	Emphatic exclamation	Agreement and answer Persuasion Break in sequence	Question	Agreement with reservation	Interjection denoting agreement and/or interest in continuing conversation

given in the second part of the previous experiment, and were used in subsequent experiments. It is intended to continue with such amendments, making use of the responses of more subjects, until the results obtained with the two methods of scoring are more nearly equal.

A similar experiment was carried out using the vocoder as a synthesizer. The same humanly-produced syllables used in all previous experiments were applied to the input. The output consisted of sounds with similar spectrums to the input, but the fundamental frequency was controlled independently by the intensity variations of the input in the same way as in the first type of synthesizer. The advantage of using the vocoder is that the output, although still a synthesized sound with completely independent control of fundamental frequency, sounds more speech-like. There is, of course, some danger that an unknown acoustic cue for intonation present in the input will also affect the output, and this possibility will have to be kept in mind.

The same subjects were again asked to repeat the test with the original humanly-produced syllables. The first method of scoring was used for marking the results. The score for correct recognition with the vocoder-produced syllables was 27% and with the original humanly-produced ones 35%. Although the score for the synthesized syllables was only 27%, it was found that the scores were never more than 5% different from the results obtained with the humanly-produced syllables. The only exception was the high rise " tone " which gave a much lower score for the synthesized syllables than for the human ones. The results show that the control of the fundamental frequency of the synthesized sounds by the intensity of the input does provide cues for the recognition of intonation. The relatively low scores obtained with the humanly-produced syllables indicate that a further revision of the test method is necessary.

All the results quoted up to the present are overall figures. A more detailed examination, now in progress, shows that the mistakes made are not random: certain " tones " are recognized much more successfully, up to 80% correct, than some others ; much information can also be gained by looking at the kind of mistake made. These and other factors affecting the transmission of intonation are being investigated.

The purpose of the experiments described in this paper was only to show some of the difficulties encountered in experiments on intonation and to indicate ways of overcoming some of them. It is hoped that they also indicate the kind of investigations, some involving sound analysis and others speech synthesis, that are needed to gain a better understanding of the physical correlates of intonation, which in turn may lead to the improvement of analysis-synthesis telephone systems.

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AN EXPERIMENT CONCERNING
THE RECOGNITION OF VOICES

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A subjective experiment is described which confirms that characteristics of the spectral envelope of speech, notably formant positions, contribute to our ability to recognise a speaker's voice. Speakers with similar accent and rate of speaking were selected and their larynx frequency characteristics were eliminated in a vocoder system with fixed voicing frequency. A direct subjective comparison of resulting voice samples showed that the speakers' voices were still highly recognisable. A proportion of the voice samples were subjected to further treatment consisting of constant shifts of formants. It was found that the recognisability of the samples was destroyed although intelligibility was unimpaired.

INTRODUCTION

An interesting study which has not so far received very much attention is an investigation of the characteristics which enable us to recognise a speaker's voice. The subject is becoming of more than academic importance because some speech transmission systems based on the analysis and synthesis of speech are now emerging from the stage where mere intelligibility is a useful criterion of performance.

There are some features of a voice which we can say from common experience contribute to recognition ; the most obvious are larynx frequency characteristics, accent, rate of speaking (Goldman-Eisler, 1954), and idiosyncrasies in speaking (e.g. hesitancy). However, even amongst speakers where all these features are similar, recognition is still often possible by a property which is difficult to define which we will call " voice quality ".

Ladefoged and Broadbent (1957) have shown that some samples of synthetic speech differing only in formant frequency range " sounded like the same sentence pronounced by people who had the same accent but differing in their personal characteristics ". This suggests that characteristic formant frequencies are a cause of the " voice quality " property mentioned above. There are of course several other features of the speech spectral envelope which might affect " voice quality ", for example, bandwidths of formants, relative amplitudes of formants and possibly the shape of the spectrum between the main formant peaks.

The purpose of the experiments described in this paper is first to confirm that voice recognition is still possible when the obvious clues referred to previously are removed, and second, to show that the strongest remaining properties contributing to recognition are connected with formant frequency.

DESCRIPTION OF THE EXPERIMENTS

The basic experiment was to allow a subject to compare two short samples of speech and to decide whether they were spoken by the same person or not. In a complete experiment each subject made many such judgments on pairs of samples which had been treated in various ways.

All the speech samples had their non-spectral recognition clues removed: talking rate, accent, and idiosyncrasies by careful selection of speakers, and larynx frequency by the use of a vocoder analysis-synthesis system to substitute a fixed frequency. In addition the vocoder was used to alter the spectral envelope of some of the samples by shifting the frequency ranges of the formants. It is apparent that for the experiment to succeed the speech from the vocoder when used normally must be good enough for voices to be easily recognised. A suitable vocoder was available and a brief description of it is given in Appendix I together with a note on the method of shifting the formant ranges. Shifting formants independently of each other by using a vocoder is rather a crude process and assumes that the formant bands do not overlap. The shifts actually used raised formant 1 by 100 c.p.s. and formants 2 and 3 by 300 c.p.s. These shifts have virtually no effect on intelligibility ; the only noticeable effect is a change of voice quality. This change is still quite noticeable when larynx frequency and other clues are present, but is not then generally sufficient to disguise a voice completely.

In the experiment the subjects compared voices selected in five different ways:
(1) Both voices of the pair from the same speaker and neither with shifted formants, referred to from now on as X-X comparisons.
(2) Both voices from the same speaker and one only with shifted formants, called X-X^T comparisons (the superscript T indicates " treatment " of the formants).
(3) Different voices and neither " treated " (X-Y comparisons).
(4) Different voices, only one treated (X-Y^T comparisons).
(5) Different voices, both treated (X^T-Y^T comparisons).

CONDUCT OF THE EXPERIMENTS

Six male speakers were selected with similar talking rates and accent and no obvious idiosyncrasies. The speech material for the experiment was produced by recording each of these speakers reading the same two 5-minute passages (one technical and the other political). A sequence of 20-second samples from the technical recordings was played through the vocoder system and recorded on the upper track of a double track tape. Samples from the political recordings were then recorded likewise in corresponding positions on the lower track. Each synchronous pair of samples on the tape was separated from the next pair by a space and an announcement of the form " Number -- ". The arrangement of pairs is illustrated below: the letters A, B ... F indicate the speaker and a small T shows that the sample was " treated " in transmission through the vocoder.

Upper Track Technical matter	Number One	A^T	Number Two	D	Number Three	F^T
Lower Track Political matter		B		C		D^T
		20 sec.		20 sec.		20 sec.

Seventy-two different pairs of samples were recorded in this way, thirty-six pairs on each of two tapes. The arrangement of pairs is shown in detail in Appendix II. It will be noted that the number of possible different pairs is not the same for all types of comparison (e.g. there are obviously fewer different X-X comparisons than X-Y). The number of pairs of each type could be equalised by rejection of some pairs in one type of comparison or by repetition in other types. Both these were considered undesirable and all possible different pairs were used for each comparison. A small trial run of four pairs was recorded at the beginning of each of the two tapes.

The experiment itself was conducted as follows:

A listener was provided with a switch permitting either the upper or lower track of the recording to be heard. He was asked to compare the voices within each pair of samples by switching from one to the other. He had then to note his decision as to whether the two samples were from the same speaker before the next pair was heard. He was not allowed to stop the tape or to replay any part of it.

Eight listeners were used in all. The order of presentation of the two tapes to each listener was randomized and at least one day elapsed between each listener's two experiments. Each listener performed the trial run before beginning the main experiment on each tape.

It will be observed that the listener only has an average of 10 seconds of speech from each voice on which to base his decision; this period was purposely kept short to prevent deep reflection by the listener; the criterion desired was "more or less immediate" recognition.

RESULTS

The table below shows the number of voice pairs whose members were considered identical tabulated for each listener and for each type of comparison.

Let us consider first the results for pairs in which neither member is treated. That some "identifications" will be registered even when the voices within a pair are different (X-Y comparisons) is of course to be expected. The proportion of such "confusions" is satisfactorily low (16%). On comparison with the large proportion (69%) of identifications in the X-X comparisons it is evident that the voice samples contain a considerable residue of recognisable characteristics.

We cannot tell from this result how thoroughly clues other than spectral envelope

TABLE 1

Type of Comparison	Total No. of Comparisons	Pairs considered to be composed of identical voices by listeners 1-8.								Total for All Listeners	% of possible
		1	2	3	4	5	6	7	8		
X-X	6	6	4	4	4	3	4	3	5	33	69
X-X^T	6	2	1	2	1	0	1	1	2	10	21
X-Y	15	0	6	0	1	3	5	1	3	19	16
X-Y^T	30	0	7	2	2	0	4	2	1	18	7.5
X^T-Y^T	15	7	9	5	8	8	6	6	8	57	47.5
All Types	72	15	27	13	16	14	20	13	19	137	

were removed from the voices, but some indication about this is afforded by the result for pairs where the speaker was the same but one sample was treated (X-X^T comparisons). The proportion of correct identifications in X-X^T comparisons is small (21%) and in fact turns out not to be significantly different from the number of identifications (which in this case are of course confusions) in X-Y comparisons. This might be interpreted as confirming that the non-spectral clues had been completely removed and that the subsequent modification of the spectral envelope then removes all remaining recognisability. There is the possibility however, that something of the non-spectral clues does remain but that the spectral modification is strong enough to disguise it. In any event the result demonstrates that the spectral envelope clues are far more potent than the other clues remaining after selection of the voices and removal of larynx frequency characteristics. There are indications in the results for X^T-Y^T and X-Y^T comparisons that either the amount of spectral modification is rather excessive or that it is of a type that does not often occur naturally. The proportion of confusions in the X^T-Y^T comparisons is very much larger (47%) than the X-Y comparisons and the difference is highly significant ; it looks as though the spectral modification common to both voices of the X^T-Y^T pairs tends to override the natural spectral differences between them. The X-Y^T results on the other hand

TABLE 2

	A	B	C	D	E	F
A	7					
B	1	3				
C	0	2	4			
D	3	3	1	5		
E	0	1	0	1	7	
F	0	3	1	3	0	7

Neither voice treated.

TABLE 3

	A^T	B^T	C^T	D^T	E^T	F^T
A	2	0	0	0	0	0
B	0	1	0	0	0	0
C	0	0	0	0	0	1
D	2	3	0	1	0	0
E	1	0	0	0	4	0
F	3	2	0	3	2	2

One voice treated.

TABLE 4

	A^T	B^T	C^T	D^T	E^T
B^T	6				
C^T	4	2			
D^T	4	4	8		
E^T	5	0	4	1	
F^T	3	2	5	8	1

Both voices treated.

show a significantly smaller proportion of confusions than the X-Y comparisons. Here again, a plausible explanation is that the modification has been sufficient to shift the treated voices into a different spectral region from the untreated voices with a consequent decrease in confusions between them.

Before leaving Table 1, it is interesting to note that the total number of " identifications " does not differ significantly between listeners. Tables 2, 3 and 4 show the experimental results for individual voice pairs, the figure in each cell is the number of listeners that considered the pair of voices were identical.

An interesting feature of Tables 2 and 3 is that unlike all the other voices, speaker F is confused more often with other voices when they are treated than when they are not. It appears that speaker F has something in common with all treated voices ; presumably he has higher than average formant frequencies. Table 4 demonstrates the obscuring effect of the spectral treatment ; with one exception every voice is confused with every other voice.

<div align="center">CONCLUSIONS</div>

The experiments described in the paper confirm that characteristics of the spectral envelope of speech play a part in recognition of a speaker's voice, and indicate that the important characteristic is connected with formant positions.

The technique relied on using a vocoder to eliminate larynx frequency characteristics and to provide changes of spectral envelope which destroyed recognisability while preserving unimpaired intelligibility. A vocoder is not ideal for the latter purpose ; this is not in this case because of any defects of speech quality as such but because the crude formant shifts produced probably do not represent very well the type of spectral differences commonly occurring between speakers. If the subject is to be investigated on the lines of the present experiment it could perhaps be better done with the aid of a formant-tracking analysis/synthesis system where the spectral envelope parameters are under closer control. However, this kind of system is not at present capable of providing speech with as high a degree of voice recognisability as does the vocoder used.

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Brief Description of the Vocoder

The experimental vocoder used for this investigation has been developed in the Joint Speech Research Unit for research into the analysis and synthesis of speech. This vocoder has been designed to be versatile as a research tool, and the arrangement of its eighteen spectrum channels is not necessarily the best compromise between transmission bandwidth economy and speech quality. The most important design requirement was that the vocoder should produce speech sounding as similar to the input speech as practicable. No larynx frequency extraction or voiced/unvoiced switch is included in the vocoder because the provision of excitation is regarded as a separate project. For the experiment described in this paper the excitation used was random noise for the unvoiced sounds and constant frequency pulses (120 c.p.s.) for the voiced sounds. Sounds were treated as voiced when they contained more than a certain amount of energy below 500 c.p.s.

The centre frequencies of the 18 vocoder channels are arranged at 180 c.p.s. spacing from 200 c.p.s. to 3260 c.p.s. The bandwidths of the channel filters and the shapes of their characteristics are the same for all channels. For convenience the analysis and synthesis are both done at a high frequency (5000-8060 c.p.s.) with appropriate frequency translation to convert between this frequency range and the original range. Each analysis channel filter consists of a coupled pair of tuned circuits whose characteristic response curve is approximately flat-topped, having a 3db bandwidth of 130 c.p.s. and a 10db bandwidth of 190 c.p.s. The synthesis channel filters are single tuned circuits of 60 c.p.s. 3db bandwidths, so arranged that when their outputs are combined to form the synthetic speech the signals from alternate channels are connected in opposite polarity.

When used with a normal excitation function the vocoder speech output is highly intelligible and voices are easily recognised. The performance as a communication link is so good that intelligibility testing is not a useful method of assessing it. The speech output is distinguishable from the input mainly by the presence of slight " harshness ".

Normally the vocoder is used with the same carrier frequency (8260 c.p.s.) for the frequency translations involved in analysis and synthesis. For the experiment described in this paper it was necessary to shift the spectral envelope in the formant 1 region by 100 c.p.s. and by 300 c.p.s. over the rest of the band. This was done by changing the carrier frequency used in the analysis side of the vocoder as shown in Fig. 1. This is a crude process inasmuch as it causes a distortion of the spectral envelope in the region where the ranges of formants 1 and 2 meet, but in practice it has been both simple and effective.
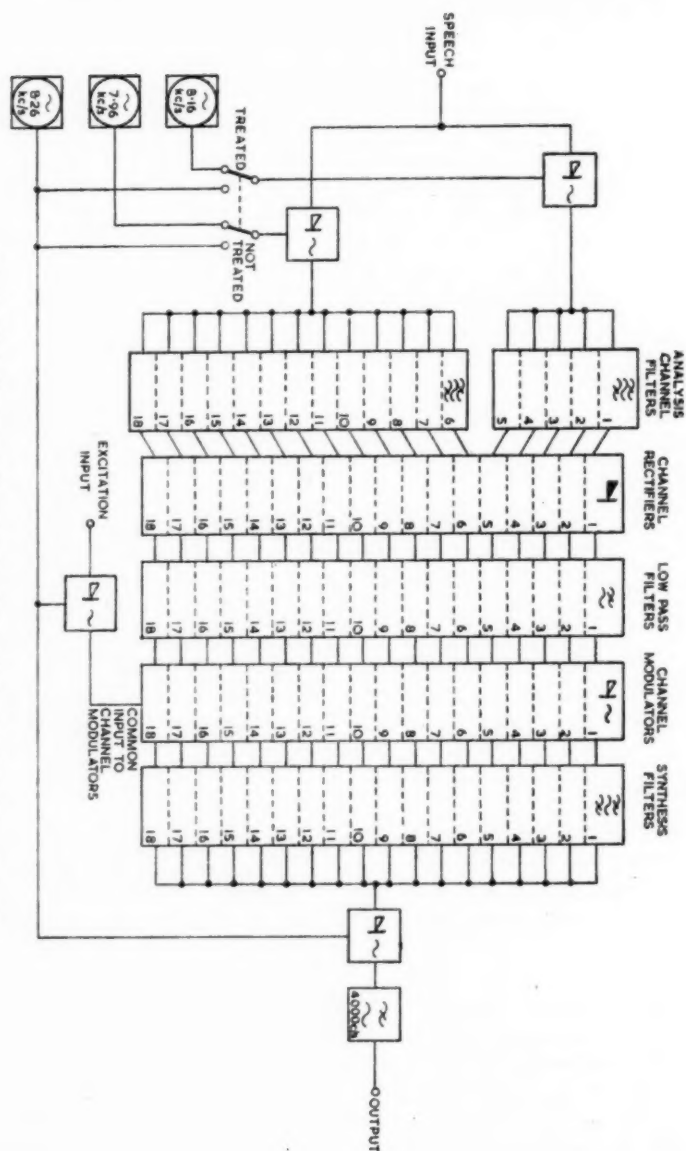
Fig. 1. Block diagram of Vocoder showing method of shifting formant ranges.

APPENDIX II

The tables below show the arrangement of pairs of voice samples on the double track tapes. The letters A, B, . . . F indicate the speakers and the superscript indicates that the voice sample was subjected to the shift of formants. The order of the pairs was decided by drawing from a " hat " slips of paper with the pairs marked on them. There are equal numbers of " treated " samples on top and bottom tracks, and (except for an unavoidable difference of one) on the two tapes.

Tape No. 1

Sample No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Upper Track	A^T	D	F^T	B^T	F	A	D^T	C^T	E	B^T	D^T	C	B	C^T	D^T	F
Lower Track	B	C	D^T	E	C	C^T	B^T	A^T	E	C	D	B	A	D	E	A

17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
E^T	A	D	B	F	B	E	E^T	C	D	C	A	A^T	F^T	B	F^T	E	A^T	E^T	C
A^T	E^T	A	D^T	F^T	F^T	D	C^T	F^T	F^T	C	A	F	E^T	B^T	B^T	B	D	F	E^T

Tape No. 2

Sample No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Upper Track	E	F	A	C^T	E^T	C	A^T	B	C^T	A^T	A^T	B	D	F	D^T	B^T
Lower Track	C^T	E	E	D^T	B	C^T	A	F	F^T	F^T	D^T	D	D	C^T	A	C^T

17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
E^T	D^T	E^T	C	F	F	B^T	E	D	B	B^T	E	F	A	A^T	D	C^T	D^T	F^T	C	
E	E^T	D	A^T	F	D^T	E^T	F^T	B^T	B	A	A^T	E^T	C	B^T	F	B	C	A	E	

PHONEME AND VOICE IDENTIFICATION STUDIES USING JAPANESE VOWELS

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A series of experiments dealing with sound quality judgments has been carried out over a long period in the Laboratory of Audiology at Nagoya University, in order to show that vowels possess two fundamental qualities, one forming the basis of phoneme identification and the other of voice identification. We present some results of quality experiments in which Japanese vowels and Japanese speakers are used and in which distortion of the band-elimination type is employed. The most general conclusion is that voice identification is far more suitable than phoneme articulation as a criterion in the technological problem of estimation or rating of speech-communication systems and speech-processing devices.

The meaning of a word is communicated partly through the tone and timbre of the speaker's voice as well as by the way he uses the word. The spoken word (not the written word) has two qualities, phonemic and vocal, which are the fundamentals of speech. The choice of words to express an idea, either verbally or in writing, may differ from person to person. The same context conveying some definite idea may be quite differently expressed according to the disposition and mood of the speaker. There is some limited degree of variation at the semantic level in the logical presentation of ideas, but nuances which reflect the emotions are of almost unlimited variation. We must first differentiate between the connotation of logic and the connotation of emotion, even though they must, as a matter of course, always be intimately connected.

When we consider timbre in connection with a study of sustained vowels, we naturally differentiate between phonemic quality and voice quality. The phonemic quality of vowels corresponds to the quality which permits identification and discrimination of phonemes in the linguistic sense, and voice quality corresponds to the quality which contributes to identification and discrimination of voices. The phonemic quality is connected with the context and the voice quality is intimately related to the difference in speakers on one hand and on the other to the difference in the way in which the speaker expresses the context and even in the differing moods of the speaker when reading the same text.

If we assume that this line of reasoning is valid, then it would doubtless be possible to devise some method which would bring out the phonemic pattern of vowels and the voice pattern of the speaker, because in human speech there must be something which is concerned with the voice element of the speaker and also with the phoneme element of the context. As " phoneme " is a concept resulting from the gradual crystallization of an idea abstracted in some way from lengthy experience in our language, so " voice " must be a concept abstracted in some other way from our daily colloquial language.

Studying and clarifying the nature of phonemic quality and bringing to light the essentials and details of the phonemic pattern of vowels, are most important both in the study of phonetics and in speech communication engineering. In the art and science of telephony, for example, from the standpoint of efficient transmission of speech when designing communication circuits and systems, and speech processing devices, it is essential to keep in mind the indispensable element of speech which contributes to articulation.

It is most significant in the science of voice and in the technique of vocal music, to keep the searchlight on the yet uncultivated " vocal " element of speech and to learn the secret of vocal shading and voice individuality. The increasing importance of the study of vocal quality comes from the demands of speech communication engineering. Let us consider, for instance, the telephone conversation. There is an essential difference in telephone conversation and face-to-face conversation because the verbal exchange over the telephone line must rely exclusively on hearing ability without any visual aid. Telephone users when conversing cannot see each other, and depend on impressions of the voice transmitted through the communication circuit for correct interpretation of the speaker. This is one of the reasons why in the technology of telephony we need a study of voice quality.

Another reason for vocal study arises from the need for " system rating " or " system estimation ". System rating based upon phonemic quality, that is, on articulation, has long been at a standstill. We need to prepare a more precise and finer scale of quality fitted to evaluate speech communication systems. System rating based upon the loudness of speech is of some value but we can expect much more from a method which is based upon voice quality in speech.

To interpret the interrelation between phoneme and voice will form a later stage of our speech study ; it calls for some advances in technique and in experimentation. It is sufficient to say here that confusion studies on phoneme and voice are the most serviceable for detecting the subtle relation between them. On this we shall have an opportunity of reporting later.

Simply to verify the point that voice quality is quite different from phonemic quality, it is convenient to show that in the mechanism of timbre perception, for example, of vowels, the characteristic of voice identification is entirely different from that of phoneme identification. In order to differentiate clearly between them the method of band-eliminating distortion (BED) is best fitted, because the mode of distribution of voice quality in the frequency dimension is conspicuously different
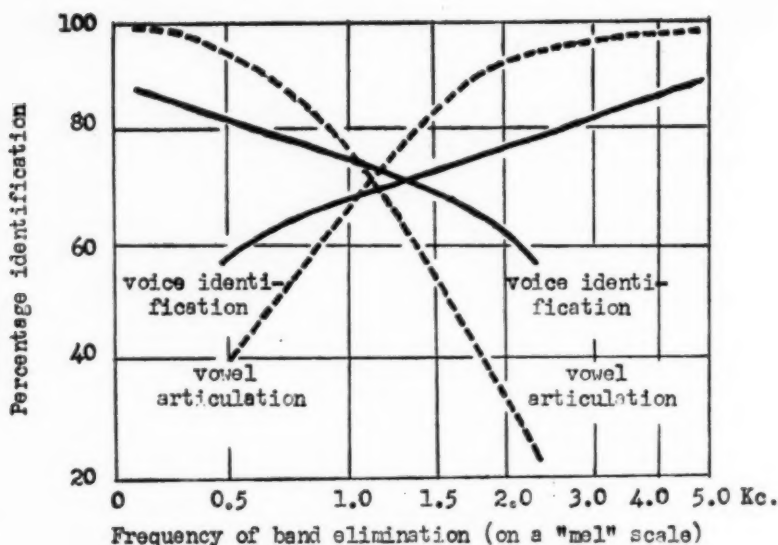
Fig. 1. Curves for vowel articulation and voice identification in experiments using band-elimination distortion. 5 Japanese vowels uttered by 4 speakers at the level of mezzo-forte on 140 c.p.s. were received by 4 listeners.

from the mode of distribution of phonemic quality. We shall illustrate this point by using the timbre of sustained vowels uttered by Japanese speakers. In Fig. 1 we show the curves for voice identification and for phoneme identification of sustained vowels in band-eliminating distortion which is one of the results of lengthy experiments repeated over a number of years, from 1953 to 1957.

In each series of experiments five Japanese vowels were used and were spoken by a variety of speakers, both men and women, up to a maximum of five speakers in a single series. For one set of experiments a child's voice was used. The number of listeners in each case was four. The vowels were sustained on a given frequency which in different experiments ranged from 140 c.p.s. to 280 c.p.s. ; in one series the vowels were whispered.

We see from Fig. 1 that the curve for voice identification is quite different in form from the phoneme-identification curve. First, the voice-identification curve is practically a straight line over most of the range ; on the other hand, the phoneme-identification curve is complicated, starting with a relatively slight gradient and usually ending with a steep gradient. Second, the intersecting point of a pair of phoneme-identification curves, that is for high-pass and low pass, seems to occur at a lower position in the frequency dimension than the intersecting point of a pair of voice-identification curves. We have called these intersecting points of the curves, " quality balancing

points." The balancing point for voice-identification is always at a higher frequency than the balancing point of phoneme-identification. The difference between absolute values of voice-identification and phoneme-identification, especially at the starting point of the curves, may be explained by the difference in the effect of practice on the members of a listening crew and in their differing reactions towards judgement of phonemic quality and of voice quality. Usually timbre judgement connected with voice identification is far more difficult than timbre judgement related to phoneme identification, and consequently the voice-identification curve is lower in position than the phoneme-identification curve. The most important thing is the difference in the shape of the curve in general and not the difference in absolute values.

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WHEN PEOPLE WHISTLE*

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The shrill, high-pitched musical sound produced when air is forced through a small opening or against a thin edge is called whistling. This paper treats whistling as a special form of human communication. A simpler form of communication than speech, it requires less training in the production and perception of sounds. Yet whistling is more difficult than noise-making, whose sounds are by-products of unskilled movements like eating or breathing and are universally understood. In terms of its history and in connection with the experiences of the whistler and the listener, whistling provides interesting information about the psychology of sound. A study of whistling therefore belongs in the analysis of human behaviour.

THE HISTORY OF WHISTLING

Though the exact function of whistling in the animal world is not known, there are many examples which may shed light on human whistling. The wild " whistling swan " of North America, for example, emits a soft, distinctive, musical tone. The large mountain marmots of the northwest also whistle, and are nicknamed " whistlers." There is a whistle pig (woodchuck), whistle fish, and whistle moth. Possibly whistling sounds serve these animals to recognize each other, to stay in groups, to frighten predators, and to time their reactions for feeding, mating, and other self-preservative acts (Lorenz, 1952).

Humans whistle by directing a stream of air through the mouth or nose. While there is almost no written information about whistling, one can assume that ancient tribes whistled (Wellesz, 1957). Instruments used to whistle, as well as visual depiction of musicians using pipes and whistles have been recovered from archeological diggings. Savages generally used whistles made of cane that were often blown with the nose. In Mesopotamia, mouth whistles capable of making one to three distinct tones were used. The Chinese employed clay whistles in the form of frogs, birds, and other

animals. Tubes of bamboo with reeds inserted into the walls were used for whistling during funeral processions, and Pekin puppet plays still use the " koouchyntzyy," a free-reed whistle, to imitate chickens and infants. The " whistle pots " of the South American Indians consisted of two communicating earthenware vessels, half filled with water.

Occasionally whistling was used as a form of language ; and such languages may have characterized many early hunting cultures. The only whistle language in existence today goes back to the 15th century. The 30,000 inhabitants of La Gomera, one of the Canary Islands, communicate by whistling, often to the exclusion of speech (Classe, 1957). Their language, called " Silbo," is audible for several miles and is ideally suited to the mountainous terrain for greeting calls, message exchange, and joke telling. Only the pitch of the whistle is varied to indicate different " words."

With the growth of instrumental music in Europe, whistles came to be used in the form of Pandean pipes, and later on as the " piccolo," or little flute. Whistles also figured in the mechanical orchestras of the 18th century. They were blown by steam or air, like high-pitched organ pipes. Instructions for the use of the bird-whistle were also published at that time. It would appear that whistling gradually came to be associated with the activities of socially underprivileged or poorly educated persons. In any event, throughout Europe and even in the United States upper class persons may tend to frown on whistling and may outlaw it in formal restaurants, art museums, and other public places.

Today whistles are also used by children as toys and by steam-kettles and policemen as warning devices. Several contemporary examples of whistling deserve mention. In the movie, " The Bridge on the River Kwai," British prisoners whistled *Colonel Bogey* while marching as a means of keeping up their morale in the face of oppression during captivity. Engineers concerned with the mechanical production of artificial speech by machines like the " Voder " make use of hissing and whistling sounds (Pierce and David, 1958).

Numerous colloquial expressions hint at the usage of whistles in social discourse. One might " whistle for " (demand) a handout, " go whistle " (tell secretly) a story, " whistle down the wind " (argue to no purpose), or " whistle off " (dismiss) an employee.

HOW HUMANS WHISTLE

It is possible to whistle without using an instrument. One simply exhales through the mouth and controls the amount of air with the speech organs. The vocal cords are abducted as in breathing, the tongue stays on the floor of the mouth, and air is expelled more or less forcefully through a small opening provided by puckered lips or spaces between the teeth. Some whistlers make a narrow opening by placing two fingers in the mouth. The pitch of a whistle can be varied by altering the shape of the mouth cavity, usually with the tongue.

The whistler uses more energy than in speech because he needs considerable muscular control and co-ordination. Those who cannot close the lips firmly or shut off air flow through the nose may have great difficulty. Children can rarely whistle adequately before the age of five or six. Uncontrolled human whistling usually occurs only when there is accidental leakage of air from the respiratory tract. Persons with articulation defects or badly fitting dentures may whistle while they speak. Artificial openings of the windpipe (tracheotomies) occasionally whistle, as do lung adhesions or cavities due to tuberculosis.

The Whistler

What the whistler experiences as he whistles is difficult to define since it involves a medley of subjective sensations and personalized values. Yet whistling, as a discrete and nicely defined bit of behaviour, has its concomitant emotions which I shall try to spell out.

To begin with, when a person whistles he experiences tension in the muscles of the mouth and face that is accompanied by buzzing and tingling feelings in the skin of the lips and the mucous membranes of the buccal cavity. Such tensions and sensations are similar to those experienced during any process that involves oral gratification—viz., biting, tasting, chewing, salivating, kissing, talking, smoking, etc. And since oral gratification, at least in those people who were mothered during infancy, involved the simultaneous satisfaction of other needs besides hunger—closeness, warmth, protection, etc.—whistling may call forth a more general hedonic state than usual in the whistler (Greenacre, 1952).

In addition to the mouth and face, whistling involves the respiratory structures. These structures—chest, abdomen, lungs, windpipes, and throat—move of their own accord, regulated by neuronal and chemical processess beyond voluntary control. But the whistler in effect willfully imposes his own rhythm, amplitude, and organization pattern on those automatic movements. Psychological studies show that if the individual is rewarded by attention or praise when he first gains control over such automatic processes, he may continue to expect satisfaction from this display of skill (Greenacre, 1952). As will be shown later, whistling arouses the attention of listeners, so that the whistler's bodily mastery is almost universally rewarded in some way.

Studies of children suggest that products of the body, like matter from digestion, warm air from breathing, or sounds from the vocal tract, may become invested with great interest, pride and pleasure once the individual masters the movements that result in such products (Greenacre, 1952). Occasionally children will play with their products, and create fantasies in which these inanimate things begin to have a life and existence of their own. Whistling results in a sound, and this, like other products of his willful effort, may be cherished and idealized by the whistler. On the other hand, whistles, like other body products, may come to be regarded as dirty and undesirable. For instance, a child may be taught to believe that his air " smells bad " or is " too noisy," with the result that he experiences guilt while whistling or stops this pleasurable activity altogether.

Some of the emotions that accompany the act of whistling would appear to result from wishful thoughts and magical fantasies in the mind of the whistler. Whistling, because it involves the production of wordless sounds, may bring back memories of that very early period during which the child could not distinguish between those sounds which came from the outside world and those sounds which came from his own body. During this phase of personality development, one is unsure of the significance of sounds. One cannot tell whether a certain noise, say one's footsteps, has personal meaning referable only to his own body or has a public meaning with some reference to the world of other people. In this confused state, the individual may come to believe that the sounds he produces have some causal relationship to what he experiences. Whistling, like other noises he makes, may thus be associated with fantasies of omnipotence which, unless corrected by reality, can lead to delusions of grandeur. Occasionally parents or other adults inadvertently encourage magical behaviour in their children and thus reinforce fanciful thoughts about whistling and other sounds. For example, nurses have been known to employ whistles to "make the child urinate," and kindly grandparents not infrequently "whistle away" the aches and bruises of a youngster.

Certain magical ideas associated with whistling are reinforced by beliefs and superstitions prevalent in the culture at large (Diserens, 1926). For example, there is an old myth among mariners to the effect that to "whistle for a wind" will bring a fresh and vigorous breeze to fill the sails. Tales about whistles are numerous in the folklore of various cultures. Suffice it to say that magic whistles which attract birds are described in Celtic tales, and flutes which have power over serpents, demons, and beasts appear in the legends of almost all cultures. Pan, the god of shepherds and flocks, invented the syrinx, a pipe that produced whistling sounds. With it he startled wanderers in the dark forest. He also used his whistle to enchant King Midas, and one day challenged Apollo, the god of the lyre, to a musical contest.

Another way to explain what the whistler experiences is to look upon whistling as a form of nonverbal signalling (Ruesch and Kees, 1956). Wordless signals usually have a vague and imprecise meaning. They do not usually communicate ideas, but serve rather to attract attention. One requirement of this kind of signal is that it must be easy to perceive by others. Whistles are sounds much easier to hear than words. They tend to be pure tones which concentrate sound energy into a narrow segment of the frequency spectrum instead of spreading it—as in speech—over a wide area. Furthermore, they occur most often in the frequency range of 1,000 to 4,000 cycles per second, to which the human ear is most sensitive. Thus the whistler can be sure to be heard by random listeners, even at a considerable distance. Alone in the woods, or on a prairie, for example, he can signal to birds and other animals. Most people seek companionship and may be rewarded with the pleasant company of a pet or a child if they whistle. In addition to making contact with another being by whistling, the whistler can expect whistling to evoke a sympathetic reaction. Nonverbal signals like yawns, laughs, or cries lead to immediate emotional rapport;

whereas words, which have to be translated and interpreted by the receiver, result in delayed or symbolic behaviour.

Last but not least, whistlers, since they produce melodies, rhythms, and other sound patterns identifiable as music, experience pleasures akin to those of the performing musician (Kohut, 1957). When he " plays on his musical instrument," the whistler conforms to some of the traditions, rules, and formulas which, over the course of time, have come to be associated with beauty. He also identifies himself with publicly adored figures such as famous composers and artists.

The Listener

Some of the effects of whistles upon a listener have been mentioned in connection with the whistler, who, whenever he is alone, is simultaneously the listener. Listening to one's own whistle may have yet another function—that of echo-location. Griffin and others have found that many animals determine their position and direction in space by listening to the reflection of their own noises (Griffin, 1958). Bats, for example, can fly in total darkness, thanks to their ability to navigate by reflected sound. Some blind persons judge distances in the same way, by a form of echo-location known as " facial vision." Whistles, as clear, penetrating sounds, may serve such a purpose, and a person who " whistles in the dark " is not necessarily afraid but merely exercising his unconscious sense of echo-location.

As to the listener who is not also the whistler, his behaviour in response to the sound of whistling is a complex pattern. Part of his behaviour is due to the fact that sounds can produce an arousal reaction. That the human organism has a deep-seated native capacity to be aroused by sounds is known from observing the startle patterns of intra-uterine infants and newborns (Greenacre, 1952). This capacity appears to be enhanced whenever the listener expects to hear a sound, as when an alarm clock wakes him from sleep or an air-raid siren alerts him in time of danger. When a person is engaged in repetitive or monotonous work, sounds tend to alleviate fatigue and to increase his efficiency. This is one reason why music is used for improving the morale and work output in factories and for reducing depressions in mental hospital patients.

Whistles not only arouse the listener, they may bother or annoy him. The high-pitched whistle of sufficient sound energy will cause discomfort and pain in the listener's ears. After continuous exposure, the listener may become temporarily deafened to the tones of the whistle ; and even permanent damage to the structure of the ear has been reported. It is reported that certain annoying sounds can precipitate convulsions in susceptible individuals (Bevan, 1955).

As the result of its arousing and annoying potential, whistling has come to be used for the purpose of controlling people—particularly people in groups (Ruesch and Kees, 1956). Thus a whistle blast may initiate a marine assault during combat. Whistles signal the start of runners, boxers, or other athletes towards their goal. In the case of human groups that are unorganized and unprepared, whistling, together with other signals, calls attention to a group leader. Such is the case of the students

who file into the classroom in an orderly fashion when the whistle blows, or the police whistle which breaks up a riot. The story of the Pied Piper of Hamelin tells about an exodus from the village of children led by the sound of a whistle. Whistles can also be used to halt movements. This fact is known to hunters who kill rabbits by causing them to stop in their tracks at the sound of a whistle. The traffic cop and the referee also " call a halt " by whistling.

Whistles convey specific meanings to the listener only when they are associated with significant ideas or images. This may happen in the case of whistles that have a specific acoustic character, such as those of whizzing bullets or speeding trains. Some people learn to identify each other on the basis of distinctive whistles ; and in some families, members have whistles which they use to call to each other over the hullabaloo of a crowd or at a distance. Occasionally whistles have a stereotyped meaning for a large segment of the community. The wolf whistle, for instance, has come to signify sexiness. Similar patterns of sound are also used to indicate amazement, surprise, astonishment, and other emotions. Rhythmical whistles that resemble the sounds of walking, the heartbeat, machinery, or other familiar phenomena are relatively easy to associate with specific thoughts or images. But much of the time whistles lack a definite rhythmic form and, like many radio sound effects, have a general sound that suggests vague ideas and moods (Turnbull, 1951). For instance, whistling that rises in pitch suggests something approaching and leads to a feeling of alarm and suspense. Whistles that fall in pitch suggest something receding and create the impression of weakness, cowardice, or failure.

If a whistle first alerts the listener and then causes him to have vague thoughts and ambiguous feelings, we say that the whistle has put him into a state of suspiciousness. He begins to wonder what is really going on, and tries to find out. He strains his ears and eyes, and searches restlessly for the origin and significance of the sound, much like a hard of hearing person who receives only a fragment of the information contained in speech. He remains dissatisfied until he locates and understands the noise. Suspiciousness can lead to panic ; it also seems to be a useful, self-protective form ot behaviour in the face of danger. For example, during World War I the British Army trained a unit of specialized " Sound Rangers " whose responsibility it was to listen for the whistles and explosions of enemy artillery bombardments (Innes, 1935). In the face of enemy submarines, sea-captains learned to listen suspiciously for tell-tale underwater sounds. For the purpose of testing machinery and motors, listeners and listening devices are employed in order to discover any whistles, rattles, and other vague noises.

Sounds are also among the most important clues for the evaluation of health and disease in clinical medicine (Douthwaite, 1954). Pathological whistling, although it does not occur as frequently as abnormal lung or heart sounds, occasionally indicates serious physical malfunction. For example, in veterinary medicine, the whistling horse requires immediate attention ; the whistle is symptomatic of obstruction of the respiratory tract because of laryngeal paralysis. Pathological human whistles include those resulting from asthma, diphtheria, and other conditions that interfere with

breathing. An inability to whistle may also be of pathological significance, and has been reported as one of the diagnostic signs of myopathy or paralysis.

Psychiatrists occasionally observe exaggerated responses to whistles in patients with emotional disturbances. These hypersensitivities are diagnostic clues that can point up severe underlying psychopathology. For example, a woman seen in our clinic gradually became tense, confused, and distractible following the birth of a child. One day her husband came home and found her in a disorganized state ; she talked continually of the whistle of the teakettle, and insisted that the whistle had stopped because " God turned it off." A psychiatrist made the diagnosis of a post-partum schizophrenic reaction and admitted the patient for treatment. After her recovery, analysis of the patient's abnormal response to whistling revealed that her mother had been in the habit of using a tin whistle to summon her children to meals. Following the birth of her child, the patient had felt a great need for help from her mother but was unwilling to ask for it directly. Instead she made great demands on her husband. When he was unable to fulfill her wishes, she began to pray to God for assistance. The patient began to imagine that she was the Virgin Mary, and in this setting she interpreted the whistle of the teakettle, which resembled that of her mother's whistle, as a sign from God.

Another patient with hypersensitivity to whistles was a man who requested treatment because of jealousy, suspiciousness, and homosexual tendencies. One day he met a girl who he became convinced was a Lesbian because he had heard her whistle. He stated that whistles were used as a secret code among homosexuals, particularly when they wanted to attract each other. Analysis of this notion led to the information that the patient's father, a clergyman, had regularly requested his son to listen to rehearsals of his Sunday sermons. The little boy, unable to comprehend the words, was spell-bound by his father's oratory and would sit in a trance throughout the sermon, seemingly hypnotized by the sound of his father's voice. The undulating and pure-tone quality of whistling always reminded him of his father's voice, and anyone who whistled exerted an irresistible fascination upon him.

THE FUNCTION OF WHISTLING IN HUMAN RELATIONS

Since whistling exists in many human and animal groups, it evidently plays a significant role in relations between individuals within these groups. In human society, whistles, like other sounds, help a person to orient himself in the world and permit him to maintain comfortable contacts with other persons at crucial moments. It is not only that the echo of his whistle provides the whistler with a sense of his whereabouts and assists him to avoid obstacles in his path. When he whistles, he hears his own sound directly, and this, like speaking, singing, humming, or any other form of sound-making, gives him knowledge that he exists. It is like looking into a mirror or touching one's body. Such self-evaluative activities prove to the individual that he is alive, intact, and awake. It is the most immediate and reliable way to reassure oneself (Ruesch and Kees, 1956).

TABLE 1

| | TRAINING REQUIRED FOR: | | |
TYPE OF SOUND	Production of sound	Perception of sound	Interpretation of sound
Spoken words	+	+	+
Tunes	+	+	
Whistling	+		
Noisy activity			

Comparison of training required for utilization of sounds.

Whistling also helps the individual to maintain his equilibrium during times of danger, boredom, fear, and loneliness when he cannot share his feelings with others or when such sharing would lead to trouble. During these times of stress or excitement, unpleasant emotions are contagious. The individual must control them, lest these emotions begin to reverberate between him and others and, like an echo, produce confusion. Whistling may strengthen his self-control. The whistler does not talk, yet he communicates. He keeps busy during the time of waiting, yet he is not over-active. This is probably why whistling, like foot-tapping, smoking, chewing, and similar activities, occurs so often when people wait for a departure, prepare for a performance, watch an operation, and endure many other tense and potentially dis-agreeable moments. Whistling " while we wait " is simultaneously energy-conserving and energy-expending. Rather than fidget about and stir up others, the person quietly whistles. Yet the activity of whistling produces some fatigue, thereby soothing and calming the whistler.

The whistler communicates too in a very specific way with his fellow man. With a whistle he implies all sorts of inner moods, motives, and thoughts which keep the listener guessing. Like other nonverbal indicators of emotions, the meaning of the whistle cannot be definitely pinned down, so that the whistler is safe from criticism, discovery, and punishment. He can get away with expressing a whole range of feelings—hate, disdain, coolness, nonchalance, pity, and tenderness—by whistling, and who will be the wiser ? He can safely express many of the things for which he has not yet learned words, or for which no words exist, or whose verbalization is out of the question at the time (Ruesch and Kees, 1956).

Thus in effect whistling can bring people closer together. It is a form of communica-tive behaviour which requires no training on the listener's part to be perceived and understood (see Table 1). While it does take practice, co-ordination, and effort to produce a whistle, whistling demands less training and skill than is necessary for speech, which requires facility with word symbols.

Whistling is even a simpler form of communication than is music because the listener must be receptive and tolerant in order to appreciate a musical message

Diserens, 1926). But whistling is not simply noise that results from random movement. Acoustically, whistling resembles a pure tone, has melodic form, and may even be rhythmical. Noises, on the other hand, are rough, irregular, and disorganized acoustic patterns. No planning or effort is needed to produce a noise, since one makes noise simply by walking, swallowing, or breathing.

CONCLUSION

From this information about whistling in human and animal behaviour, whistling appears to be a special form of communication which lacks the complexity of speech and music, yet is more complex than simple noise-making. The experiences of the whistler concern mouth and body movements that may be pleasurable, as well as thoughts and emotions that range from excitement to depression. An analysis of the effects of whistling upon listeners shows that whistles arouse, annoy, alarm, and control others. Finally, whistling has its function in human relations. Whistling seems to help calm a person who is in danger and distress. It reinforces the whistler's belief that he is alive and aids in self-orientation. By whistling, an individual can establish contact with others. People whistle to communicate feelings which cannot be readily expressed in words.

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VOCAL BEHAVIOUR: THE DURATION OF SPEECH UNITS*

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Recordings made of 20 subjects in two role-playing sessions were analyzed to obtain the pattern of the durations of speech units for both the subjects and for the standard-role-player. Overall curves of the distribution of durations did not reveal marked differences between the two role-playing sessions. The distribution was then divided into four parts in order to discover which portions might vary with the three dimensions of situation, speaker, and listener. The data are interpreted in terms of the proportion of very short utterances as providing feedback and reinforcement from the listener, the proportion of long utterances as related to relatively stable characteristics of the speaker, and those of intermediate length as showing an interaction of speaker and situation.

Recordings of speech, when filtered to remove verbal content, have been found to contain information related to the personality of the speaker and to his emotional state (Starkweather, 1956a, 1956b). The results indicate that a listener can make use of vocal cues without the context of verbal content, and these conclusions should bolster the convictions of some (e.g. Goldman-Eisler, 1951) regarding the importance of expressive, non-content aspects of conversational behaviour. Those who have listened to content-free recordings reliably agree in judging emotional characteristics, but it is not entirely clear what combination of vocal dimensions contains such information. A wide frequency range of sound is involved in these dimensions, and this study may be considered an exploration of the extreme low-frequency end of this range: a consideration of information carried by the pattern of on-off speech units.

In early work with the interaction chronograph, Chapple (1940) presented some data about the distribution of utterance durations. He asserted that the distribution could be fit by the sum of two exponential curves, and in addition, he presented some relationships between constants of the distribution on which individual subjects differed. He did not follow this work, however, with further studies of the distribution related to individual or situation difference. Goldman-Eisler (1951, 1952), using the interaction chronograph, has investigated time sequences of actions and silences in conversation, and indicated that certain ratios of action and silence tended to be characteristic of individuals and not easily changed by different partners or by different topics. On the other hand, the data from trained interviewers indicates that they adjusted the total of their actions to different types of patients. Use by others of the interaction chronograph (Matarazzo, Saslow, and Matarazzo, 1956) has not emphasized investigation of the utterance duration pattern. An unpublished study by Hargreaves (1955) analyzed the distribution of utterance durations of a single subject interacting

with his wife and friends through a full day of recording. The distribution of many conversations could be fit by a single exponential curve, but in some cases an excess of long utterances was also present, but with insufficient data to allow a curve fitting approach to them.

A special vocal characteristic may be related to personal style and be relatively insensitive to situational differences. It may also be relatively unchanged by behaviour of the listener. On the other hand, a vocal characteristic may be variable for the speaker, easily influenced by the listener, or be dependent upon whether the speaker is in a conversational interchange or delivering a speech. It would obviously be well to sample these three influences: situational differences, speaker differences with the same listener, and listener differences with the same speaker. This study proposes to approach this problem, using recordings made in role-playing sessions which seem to fit the requirements.

Different subjects played a pre-arranged part opposite the same staff member (the standard-role-player) and the recordings were available for two such situations for each subject. It was possible to obtain utterance duration measures for the standard-role-player speaking to many different subjects in the same situation, and also for the different subjects speaking to the same standard-role-player. These recordings were of the same role-playing sessions used in a previous study in which content-free speech was judged for information about the speaker.

METHOD

The subjects and recordings used are described in an earlier paper on content-free speech (Starkweather, 1956b). From available recordings from 90 subjects, two random groups of ten were selected. The same analysis was carried out in all respects for these two groups, and when no differences were found between the two groups of ten, the results were pooled.

In the first situation, the subject was asked to play the role of a spokesman for his fellow salesmen to protest against the firing of a sales manager whom they all respected. In this situation, the standard-role-player acted the part of the vice-president. He evaded any explanations of the firing of the sales manager, but offered the same position to the subject, making it as attractive as possible.

In the second situation, the subject was assigned the role of a young man who had recently inherited his father's business. He was told that he had adequate training and experience for the position, but that he had been away in the service ; that he now finds many practices of the company to be out of date, but his plans are blocked by the general manager. He has been debating whether or not to fire the general manager, and has called him in to see him. In this situation, the standard-role-player played the general manager.

A frequency distribution of utterance durations was obtained by means of the duration tabulator (Hargreaves and Starkweather) which tallied durations in one-second class intervals. In order to analyze a single voice from these recordings, a listener operated the duration tabulator by pressing a key during the speaking time of the
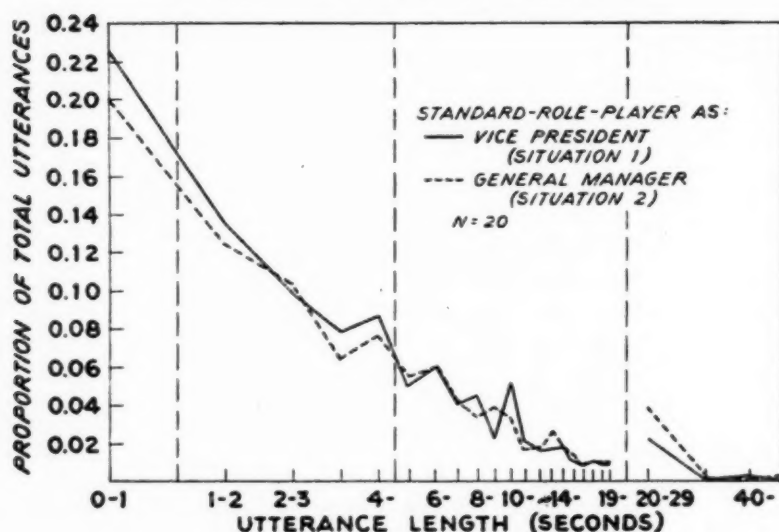
Fig. 1. Mean pattern of utterance length for the standard-role-player in two situations.

voice being analyzed. The listener had essentially one task ; that of identifying the voice and responding immediately, since it had been previously found that the additional task of defining an utterance led to low reliability of the process. By definition of the utterance is meant the decision of whether the same utterance is about to continue or whether a new one is beginning. This decision was built into the apparatus in terms of an arbitrary pause time, and in the present instance, a pause of one-second or more re-set the apparatus to begin timing a new duration, while a pause of less than one-second was ignored.

RESULTS

The first situation varied in elapsed time from 6'-8" to 13'-57", with a mean of 9'-22". The second situation varied in elapsed time from 5'-11" to 12'-35", with a mean of 8'-56".

Fig. 1 shows the pattern of utterance durations for the standard-role-player in terms of the proportion of his total number of utterances. Each point represents the mean of 20 proportions, since the figure represents his mean performance when playing opposite 20 subjects. The total number of utterances by the standard-role-player in Situation 1 (vice-president) varied from 23 to 59, with a mean of 39.5. The total number in Situation 2 (general manager) varied from 16 to 35, with a mean of 26.0.
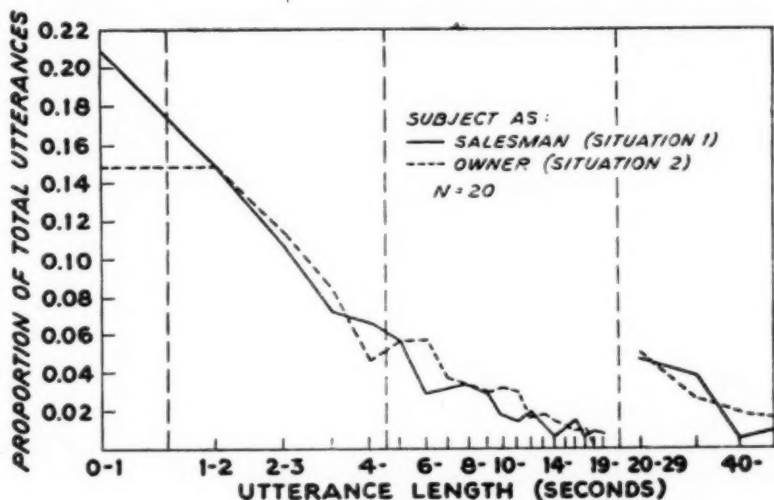
Fig. 2. Mean pattern of utterance length for subjects in two role-playing situations.

Fig. 2 shows the pattern of utterance durations for the 20 subjects in the two situations. Each point here represents the mean of 20 subjects playing opposite the standard-role-player. The figure is again in terms of the proportion of each subject's total number of utterances in the situation. The total number of subject utterances in Situation 1 (salesman) varied from 22 to 62, with a mean of 36·6. The total number in Situation 2 (owner) varied from 14 to 61, with a mean of 37·2.

In order to discover which portions of the distribution might vary with the three dimensions of situation, speaker, and listener, the data were separated into four divisions based on the usage of previous investigators. These divisions were 0 to 1 second, 1 through 4 seconds, 5 through 19 seconds, and 20 seconds and over. The mean proportions and their standard deviations when grouped in this way are shown in Table 1. It should be realized in interpreting these data that standard deviations for the standard-role-player indicate his variability when speaking to 20 different subjects. The data for the subjects, however, is the variability between the 20 different subjects when talking to the same standard-role-player.

As a test of change in the distribution related to change in situation, comparisons were made for each of these categories of duration for the standard-role-player and for the subjects. Eight direct-difference *t*-tests were made, only one of which was statistically significant (p < 0·05). The subjects gave consistently more very short (0 - 1 sec.) utterances in the first situation as salesman than they did in the second

TABLE 1

Category of Utterance Duration (Seconds)		Standard-Role-Player		Subject	
		Sit. 1	Sit. 2	Sit. 1	Sit. 2
0 - 1	Mean	0·225	0·201	0·211	0·148
	σ	0·089	0·105	0·104	0·151
1 - 4	Mean	0·394	0·360	0·394	0·392
	σ	0·073	0·136	0·154	0·402
5 - 19	Mean	0·338	0·388	0·309	0·346
	σ	0·106	0·140	0·129	0·354
20 +	Mean	0·027	0·056	0·094	0·110
	σ	0·037	0·045	0·111	0·113

Means and standard deviations of proportions of total utterances by grouped durations (N = 20).

TABLE 2

Category of Utterance Duration (Seconds)	Standard-Role-Player	Subject
0 - 1	+0·49*	+0·11
1 - 4	+0·02	+0·53**
5 - 19	+0·15	+0·56**
20 +	+0·33	+0·67**

* *Significant at 0·05 level of confidence.*
** *Significant at 0·01 level of confidence.*

Rank-order correlations between Situation 1 and Situation 2.

situation as owner. In three cases the variances involved in these tests were not homogeneous. The standard-role-player became significantly ($p < 0.01$) more variable in the proportion of 1 - 4 sec. utterances in the shift from Situation 1 (vice-president) to Situation 2 (general manager). The variance between subjects in 1 - 4 and 5 - 19 sec. utterances was significantly ($p < 0.01$) greater in the same direction from Situation 1 (salesman) to Situation 2 (owner).

Consistency figures in the form of rank-order correlations were obtained for the standard-role-player and for the subject when shifting from one situation to the other, and are presented in Table 2. The correlation is significant for 0 - 1 sec. utterances for the standard-role-player while it is not significant for longer durations. The reverse is true for the subjects since they are not consistent for 0 - 1 sec. utterances, but correlations are significant for all longer durations. It should be kept in mind that the data for the standard-role-player indicate his relative consistency in dealing

with the same subject in a second situation. The data for the subjects indicate their maintenance of rank-order when talking to the same standard-role-player in two situations.

DISCUSSION

The recordings used here were studied with the hope that they would offer a small sampling of three influences on the duration of speech units. These were: 1) differences related to the speaking situation ; 2) speaker differences with the same listener ; and 3) listener differences with the same speaker. Some differences in duration pattern have been found which can be related to these three kinds of influence.

Certain gross differences should be noted between the data under study here and that produced by Chapple's interaction chronograph (Chapple, 1940). First, of course, this study is dealing with vocal behaviour alone and does not include facial expression and gesture included in the interaction chronograph's " actions ". In addition, the analysis of interaction chronograph variables does not normally include analysis of the pattern of durations. A description of those variables which are obtained has been presented by Matarazzo, Saslow, and Matarazzo (1956).

Goldman-Eisler, using a somewhat different version of the interaction chronograph, has paid some attention to the use of utterances of different durations. In one study (Goldman-Eisler, 1951) she divided short silences and actions from long ones with a division point of 20 seconds. Ratios of these measures were presented as evidence for stable characteristics of individual behaviour. In another study (Goldman-Eisler, 1952) the duration used as a dividing point between short and long silences and actions was five seconds. Since her data was presented in the form of ratios it is not directly comparable to that obtained here, but it was decided to use both her divisions of 5 sec. and 20 sec. in this analysis.

In addition, those utterances of less than one second duration were handled separately because of the possibility that they might have a specific kind of psychological meaning. Such very short utterances probably operate, for the most part, as a feed-back device, interjected in conversation by a listener to show interest and express some degree of agreement or disagreement. The extreme case of their use is probably in a telephone conversation where some of this information cannot be carried by gesture or facial expression. These very short utterances are of special interest because of their action as reinforcements to aspects of the speaker's behaviour. Here I am referring to studies called verbal-conditioning recently reviewed by Krasner (1958).

The present data does not indicate great differences between the two role-playing situations. In fact, all four curves shown in Fig. 1 and Fig. 2 are remarkably similar in shape. A preliminary sampling of unpublished data being presently gathered by Hargreaves makes it clear, however, that consistent differences in such curves do exist when truly different real-life situations are sampled. Fig. 3 shows the mean data for four subjects who were recorded in three situations which differ in the amount of personal interaction and also in the necessity for thought. Large differences of this sort would not be expected between our two samples of role-playing behaviour which are both a type of interaction.
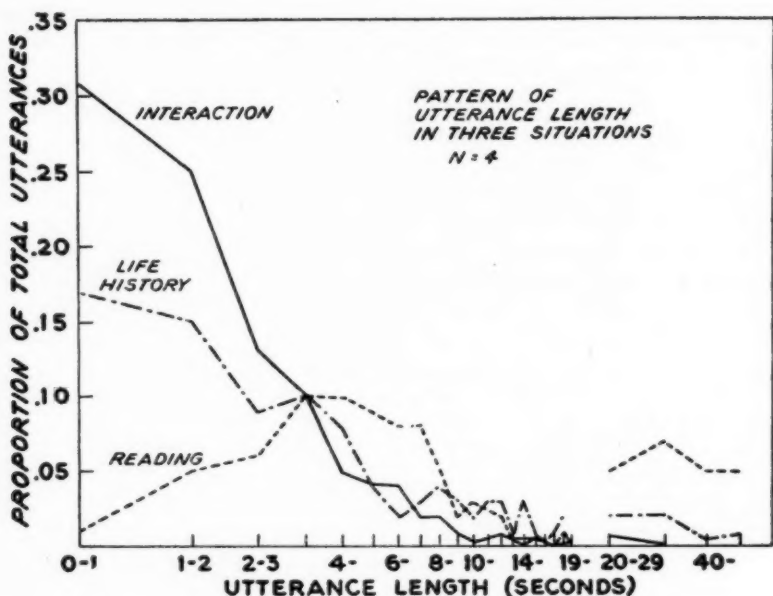
Fig. 3. Mean pattern of utterance length for three types of situation.

It should be pointed out that Situation 2 always followed Situation 1. Therefore, the differences which do exist between the two could be the result of the subject's adaptation to the procedure, rather than due to the pre-arranged shift in role. Thus, the significant drop in 0 - 1 sec. utterances for the subject might be the result of his increasing familiarity with the procedure resulting in fewer hesitations.

Each grouping of durations will now be considered separately as a particular type of verbal behaviour and some conclusions drawn about its characteristics.

0 - 1 sec. The standard-role-player varies with different subjects and is consistent with the same subject in the two situations. A caution should be inserted here, however, that this consistency may be the effect of the standard-role-player's behaviour on a particular day rather than with a particular subject. This contamination of data exists because, although some subjects were seen on different days, the two roles for the same subject always occurred on the same day. All subjects, however, were dealing with the same person and experienced the same two situations. For 0 - 1 sec. utterances the subjects do not maintain their ranking, but show a mean difference with the situation. This behaviour category is therefore not consistent for the individual, but is influenced both by a change in listener and by a change in the situation.

1 - 4 sec. In this category the standard-role-player varies with different subjects, but is *not* consistent when dealing with the same person in the two situations. The subjects, however, maintain consistent relative rank but show no mean change related to the situation. An interaction of subject and of situation is suggested by a marked increase in variability between the subjects in Situation 2.

5 - 19 sec. The pattern here shows very little difference from that of the 1 - 4 sec. durations. Interpretation is generally the same.

20+ sec. This behaviour category shows the least variability for the standard-role-player and also the greatest consistency for the subjects. The measure shows relatively little change with a change of situation and has the greatest possibility as a measure of individual style. In general, this is in keeping with Goldman-Eisler's (1951) suggestion that individual differences should reveal themselves most distinctly in the durations of more than 20 sec.

If these long durations of greater than 20 sec., are not easily influenced and the very short durations of less than one second (and perhaps a little longer) act as reinforcements and as feedback, then it must be durations in the middle range which are those most influenced by feedback from the listener. These data do not suggest, however, that this is a simple effect, but rather that there are differential effects on different subjects.

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JOSHUA STEELE AND THE MELODY OF SPEECH

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In 1776 Joshua Steele published a work describing and illustrating his system for transcribing the suprasegmental aspects of speech. Despite certain shortcomings, that method allowed transcriptions of relative duration, pitch, and clause terminals to be recorded as accurately as those sound attributes could be observed. The work was discussed, and its utility investigated at the time, particularly by a group corresponding on linguistic issues with the president of the Royal Society. But by the end of the eighteenth century, Steele's method was largely neglected, primarily because the requisite technological assistance for putting it to use had been unavailable, though partly because academic attention had mainly turned from descriptive to historical linguistics. Nevertheless, the value of Steele's pioneering effort was recognized by Melville Bell and A. J. Ellis. Thus its formulations were absorbed into the main stream of nineteenth century descriptive work, albeit not without creating an exaggerated image of their faults.

LINGUISTIC STUDY IN THE EIGHTEENTH CENTURY

When Boswell repeated with approval Lord Pembroke's pleasant observation that " Dr. Johnson's sayings would not appear so extraordinary, were it not for his *bow-wow-way,*" the zealous biographer added a fond wish that his subject's " mode of speaking . . . could be preserved as musick is written, according to the very ingenious method of Mr. Steele, who has shown how the recitation of Mr. Garrick, and other eminent speakers, might be transmitted to posterity *in score* " (Boswell, 1934). Unhappily, this was never done, and even the system explained in Joshua Steele's *Prosodia Rationalis* has, after attracting a brief flurry of interest, and a handful of followers, been either forgotten or misunderstood. Among those few who have kept its memory green, opinion has been sharply divided. In the twentieth century, only two writers have told us much about Mr. Steele's ingenious method—and not very much, at that. George Saintsbury, writing on the history of English prosody, less than ten years after Queen Victoria's death, would have us believe that " His results are not good: they are bad, absurd, revolting" (Saintsbury, 1908). T. S. Omond, also writing from the viewpoint of an interest in prosody, and some fifteen years before

the phoneme theory had become sufficiently well known on both sides of the Atlantic to create a new outlook in linguistics, agreed that " those who judge only by results may turn from him in disgust." But swallowing all revulsion long enough for a closer look, Omond did praise " The admirable skill with which he dissected our complex speech," remarking that his " analytic work " was " profoundly original ... subtle and penetrating " (Omond, 1921). It would be very curious indeed if a work of such originality yielded completely discreditable results. And it is certainly most striking that Steele's warmest defender as well as his sternest critic viewed his transcriptions with equal distaste. Perhaps it is now possible to arrive at a more balanced evaluation of both those transcriptions and their subsequent disrepute.

Yet, to appreciate Steele's system, it must be viewed against the backdrop of other linguistic study in the eighteenth century. The extent and significance of early work in this field has not always been recognised. In 1938 Martin Lehnert wrote that " Die Erkenntnis, dass die Wurzeln des modernenglischen Phonetiksystems im 17. Jh. liegen, ist neu." And as recently as 1948 David Abercrombie observed that " There is, in fact, a firm opinion in some quarters that before about 1830 there was no such thing as phonetics." He also pointed out one reason for that notion, explaining that " Early writers on phonetics and alphabetics have usually had attention paid to them only in so far as they throw light on the pronunciation of their time. Writers who offer little evidence for this purpose, whatever their interest as linguistic thinkers, have received correspondingly little attention." This probably accounts for the oblivion in which Steele has been allowed to remain of late, because his work only touches lightly on articulations and the segmental aspects of speech. A few paragraphs in his preface are devoted to vowel and consonant pronunciation, but the main business of *Prosodia Rationalis* is an analysis of the suprasegmentals—length, stress, and voice-pitch—in order to formulate a system of notation permitting accurate transcription of these features of speech.

There had been no such determined attack on that particular citadel before, although there was no shortage of armchair strategists who recommended the manœuvre. Abraham Tucker, for example, is typical in excusing himself from the assault by confining his discussion of *Vocal Sounds* (1773) " to the articulation, not meddling with the various tones " (Abercrombie, 1948). Yet, as Omond has noted, " Gildon had desiderated ' prick't notes ' like those of music. Say and the others of his group had referred much to music, and had represented ' feet ' by notes.... Foster asserted that ' every sentence uttered ... is ... capable of musical notations.... [and] Kames contended that for accurate recording of pronunciation ' notes must be invented, resembling those employed in music '." But, like Tucker, each assiduously occupied himself with some less hazardous affair, while nevertheless enthusiastically urging the others unto the breach once more.

The range of safer activity, moreover, was very wide. One can list the grammarians —including classicists, and antiquarians such as the Elstobs and Hickes ; lexicographers, of whom Dr. Johnson, though not alone in that occupation by any means, is the most famous ; orthoëpists such as Nares and Sheridan—who also avoided ' meddling

with the various tones ' ; inventors of shorthand systems ; the inevitable advocates of spelling reform crying in an orthographic wilderness ; poets and critics wrestling—as Steele himself did—with the problems of prosody ; and even those who, following in the contentious footsteps of Holder and Wallis, interested themselves in teaching the deaf and dumb to speak.

But more important to an understanding of Steele's milieu than any list of mere activity, are the underlying philosophical assumptions which partially governed, and thus help to explain, the directions taken by individual discussions of language and speech. Specifically, it is most helpful to examine any particular eighteenth century linguistic enterprise in relation to the contrasting philosophical outlooks known as empiricism and rationalism. Each, as William James has pointed out in drawing his famous distinction between the ' tough-minded ' and the ' tender-minded,' reflects a particular temperament, an emotional attitude towards the universe. He identified the empiricist as " your lover of facts in all their crude variety," while the rationalist is " your devotee to abstract and eternal principles." Yet, as he was quick to add:

" No one can live an hour without both facts and principles, so it is a difference rather of emphasis ; yet it breeds antipathies of the most pungent character between those who lay the emphasis differently ; and we shall find it extraordinarily convenient to express a certain contrast in men's way of taking their universe, by talking of the ' empiricist ' and of the ' rationalist ' temper. These terms make the contrast simple and massive."

In examining Steele's work it will also prove extraordinarily convenient to keep this contrast in mind. For eighteenth century attitudes towards language and speech display the cleavage in a most striking manner.

Rationalism predominated, represented in philosophy by the Cartesian—though ultimately Neo-Platonic[1]—doctrine of innate ideas, in literature by neo-classicism, and

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[1] *Otto Funke has pointed out that the doctrine of innate ideas " geht in letzter Linie auf Plato zurück, und sie zieht sich dann in der Frage nach dem Apriori bis zu Kants apriorischen Formen und Husserls ' idealen' Bedeutungen herauf. Aristoteles hat hier bereits Kritik angelegt, und die englischen Empiriker sind jener Meinung entgegengetreten* " (1927).

He has also noted that Locke's philosophy provided a meeting-ground for linguistic and epistemological concerns, remarking that " Wie die naturwissenschaftliche Forschung ... das äussere Weltbild zu klären und zu systemisieren unternimmt, so wendet sich die Philosophie dem Bereiche des Geistigen zu und beginnt, die psychologischen Grundlagen der Erkenntnis zu erhellen und die Erkenntnismöglichkeiten zu prüfen ; damit tritt auch das Sprachproblem in den Kreis philosophischer Interessen ein. Die allgemeine Funktion der Sprachmittel sowie ihre Bedeutung als Denkhilfe beschäftigen J. Locke im 3. Buche seines 'Essay concerning Human Understanding' ... " (1934).*

Leonard observes that Locke's Essay " provides the basic philosophy for an objective and scientific study of linguistic problems " (1929). But the consequences of rejecting—or accepting—the doctrine of innate ideas are not discussed. As we shall see, however, the stand taken, implicitly or explicitly, on that issue could be of crucial importance to a student of language. In Steele's work, the role assigned to an innate idea resulted in an unnoticed terminological ambiguity that had direct bearing upon the efficiency of his system for transcribing suprasegmental aspects of speech.

in linguistic studies by the prescriptive attitude towards language. Descartes had insisted that the ideas of self, God, space, time, and motion, as well as those of the geometrical axioms, were all innately given, whereas Locke, and the subsequent school of British Empiricism regarded the entire content of the mind as derived from experience. The views of Dryden, Pope, Swift, Johnson, and the other literary giants of neo-classicism are well known. And the " Doctrine of Correctness," as prescriptive grammar has been termed, was manifested by the growth and decline of a movement to establish an academy for the purpose of halting the slow drift of linguistic change, as well as by the prevalence of " normative " approaches to questions of grammatical usage (Leonard, 1929). But the central aspect of the prescriptive attitude, appearing throughout all the various activities it influenced, was a notion that linguistic phenomena were to be forced into alignment with certain predetermined principles, and not vice versa.

Yet there was a strong countercurrent of empiricism, represented in philosophy by the rejection of innate ideas, in literature by the beginnings of the romantic movement, and in linguistic studies by the descriptive approach to language. Steele, for example, largely shares the empiricist outlook, which is reflected in an assertion that his " intention was not so much to show how ... words should be pronounced, as how that pronunciation, whether right or wrong, should be marked " (p. 216).

It is necessary to realize that *both* rationalism and empiricism play an active role throughout the eighteenth century. To be sure, rationalism was predominant, just as, in a see-saw, one side is usually more visible from a distance than the other ; but empiricism was gathering momentum for an immense upswing ; and *Prosodia Rationalis* may be viewed as part of that process. In linguistic study the nineteenth century saw a renewal[2] of intense efforts to describe the facts of speech " in all their crude variety," while in literature, the romantic movement swung artistic attention from the general to the particular. Turning to an examination of Steele's *Essay Towards Establishing the Melody and Measure of Speech,* whose further subtitle declares that those phenomena are *To be Expressed and Perpetuated by Peculiar Symbols,* it is possible to discern the consequences of a clash between an empiricist devotion to facts and the persisting rationalist longing for abstract and eternal principles.

STEELE'S ' PECULIAR SYMBOLS '

Although Steele " had long entertained opinions concerning the melody and rhythmus of modern languages, and particularly of the English," he did not systematize those views until his " learned and honoured friend Sir John Pringle, President of the Royal Society," asked for " an opinion on the *musical part* of a very curious and

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[2] *J. R. Firth has pointed out that " It is in the seventeenth century and in the Royal Society group that emphasis is first laid on the sensory disciplines, and especially on hearing, training the ear, the eye, and close visual observation, and introspective observation of the organs of speech and the mechanism of utterance " (1946).*

ingenious work lately published at Edinburgh, on *The Origin and Progress of Language*, which " would be found " principally in Part II, Book ii, Chap. 4 and 5 " (pp. 1 - 2). Lord Monboddo, the author of this book, had asserted that while " we have accents in English, and syllabic accents too . . . there is *no change of the tone in them ;* the voice is only raised more, so as to be louder upon one syllable than another," and hence—inasmuch as there is no " difference of tone betwixt the *accented* and *un-accented* syllable of any word,"—one must conclude that " the *music of our language,* in this respect, [is] nothing better than the *music of a drum,* in which we perceive no difference except that of *louder* or *softer* " (p. 3). Steele, whose own observations pointed to quite different conclusions, could not allow the Scottish Lord's assertions to remain unchallenged. Therefore, complying with Sir John's request, he took up his pen for the immediate task of controverting the foregoing propositions: English must not be regarded as little more than a concatenation of rude thumps.

The first steps toward the accomplishment of that assignment had apparently been taken well before the President made his request, and comprised " repeated experiments on his own language " (p. 194). These were carried out with the aid of a bass viol, in order to determine both the absolute range of pitches through which his voice was capable of sliding, and the manner of progression from tone to tone. As to the first matter, Steele reports as follows:

" I made trial of the fundamental (or deepest note on the instrument) that seemed to be key-note to the common level of my voice in speaking, which I suppose to be C of consort pitch, and made use of the open tone of the fourth string of a violincello, which was the octave below my common level. I found my slides in common discourse went about a fifth (of the diatonic scale) above the level or key-note, and about a seventh below it ; but if empassioned, it run [sic] two whole tones higher, which made in the whole extent a compass of 13 notes, or octave and sixth " (p. 37). Having thus satisfied himself that a wide range of tonal variation could be discerned by this method, the second question was easily disposed of, for it was remarked that " the changes of voice . . . do not proceed by pointed degrees coinciding with the divisions of the chromatico-diatonic scale ; but by gradations that seem infinitely smaller (which we call *slides*) ; and though altogether of a great extent, are yet too rapid (for inexperienced ears) to be distinctly sub-divided ; consequently they must be submitted to some other genus of music than either the diatonic or chromatic " (p. 17). Furthermore, it was observed " that these *changes are made,* not only *upon words* and *upon sentences,* but upon *syllables.*" On the basis of the foregoing observations, Steele unequivocally declared " That the sound or *melody of speech* is *not monotonous,* or confined like the *sound of a drum,* to exhibit no other changes than those of *loud* or *soft* " (p. 17).

It is noteworthy that Steele not only rested his case upon systematic observations carried out under definite and reproduceable circumstances, but also that he invited others to put his conclusions to the test of their own ears under like conditions: he was never unwilling " to submit these several examples to the judgment of common ears " (p. 15). Thus, on the issue of intonation, Steele's ultimate appeal is to the

observable phenomena of English speech, rather than to any authoritarian pronouncement. Moreover, he explicitly denies that our own language must necessarily display features analogous to those found in the classical tongues: " as far as any of his terms, propositions, or rules, agree with those laid down by the antients, or their commentators, for the Greek or Latin languages, he considers them as lucky incidents that tend perhaps to prove their truth, which however he did not designedly provide for ... " (p. 194). In all these respects, Steele is atypical. A lively concern for living fact, even at the expense of received principle if need be, does not reflect the dominating rationalism of the century in which he was born.

With the fact of tonal variation established, the next steps were clear: it was necessary to devise a system for describing—and clearly differentiating—the various phenomena discernible in the stream of speech. Then that system had to be applied to the business of recording utterances as precisely as possible. Finally, Steele had to explain his formulations convincingly at second hand through the silent medium of the printed page. To help overcome the difficulties bedevilling written explanations of pronunciation, each successive part of the work was sent off to Edinburgh for Lord Monboddo's comments, which were then, in turn, used as a starting point for further clarification. As Steele explained to his Lordship, " nothing can tend so much to elucidate any subject as the queries of an ingenious doubter. And it is natural to suppose, that some or all those which your l——p has made, would have come into the minds of other ingenious men ; therefore, as my design was to find out and establish *a truth*, I was very well pleased to have them fully stated, that I might have the opportunity either of correcting myself, or of obviating all other probable objections by my answers to *them* " (p. 181). Consequently, *Prosodia Rationalis* is, in effect, an extended dialogue between the two men, to which is appended, in the second edition, an additional series of questions from other hands, together with the author's replies. Steele preferred a certain diffuseness of exposition in order to provide readers with a fair look at both his system and the objections that could be brought against it. No evidence is suppressed for the sake of brevity or systematic neatness of presentation. In this respect, as when the reader is urged to take up a bass viol and see about intonation for himself, one is invited to weigh and consider, rather than merely defer to the experts.

Five terms were considered " sufficient to distinguish clearly the several properties or accidents belonging to language " (p. viii). These were *accent, quantity, emphasis, pause,* and *force,* each of which is discussed at some length.

Steele used *accent* to mean pitch or intonation, which was to be represented on a musical stave, although in most cases the stave is dispensed with, leaving only a transcription of relative height, thus eliminating all indication of absolute pitch. Slides up (or down) to—and usually through—the focal pitch of each syllable are noted. The elaboration and application of this method of transcribing intonation curves represents a distinct innovation. As Omond remarks, " while earlier writers merely played with this notion, Steele put it into practice. What they only desiderated he tried to perform." Moreover, his performance was convincing.

Lord Monboddo, at any rate, professed himself convinced, saying that, " As to the melody of our language, I once thought that there was no tone in it, but what was either provincial, or what belonged to some passion, humour, or sentiment. But you have convinced me, that even when we speak in the plainest manner, and as much upon a level as possible, still there is not a perfect monotony ; but the voice is perpetually sliding up and down, more, as you observe, in public speaking, or even the conversation of men from the country, less in the conversation of men bred at court " (p. 103). Thus Steele succeeded in drawing his Lordship's attention to the fact that tonal variations occur as the rule, rather than the exception, even in the speech of well-bred city folks who are not tearing a passion to tatters. But this was not all. He went on to refine those observations, noting in greater detail the role played by intonation: " In our language, generally, the last syllable of any imperfect sentence (while the attention is to be kept up, for the sense of the whole, yet in suspense), ends in the *acute* [rising pitch] ; and all compleat periods end in the *grave* " [falling pitch] (p. 87). Moreover, the mechanism by which intonation is drawn into service for emotional expression is hinted at: " The tones of passion are distinguished by a greater extent of the voice both into the *acute* and the *grave,* and by making the *antithesis,* or diversity between the two, more remarkable . . . " (pp. 191 - 192). Finally, Steele was fully aware that despite the ubiquity of small tonal slides within every syllable, not all such variations are significant enough to alter the sense of a word or phrase. He remarks that besides the " necessary licences of variation, there is also a manner of *gracing* the *tones ad libitum,* as in singing," adding that he has made " this remark in order to shew that different speakers, or the same speaker at different times, may all be essentially in the same *accentual tones,* though a little disguised by the use of graces or *appoggiaturas ;* that is, like musicians severally playing the same air, though some grace it with variations, while others play only the plain notes " (p. 145 - 146). In short, Steele clearly recognized both the presence of tonal variations in English, and their importance as one of the signals by which " the different *meanings* of words, formed by the same, or nearly the same, literal sounds and syllables, are distinguished " (p. 88).

Emphasis and *quantity* both involve the time-dimension of speech, " The term QUANTITY is appropriated to discriminate the relative value of sounds in duration of time . . . that is, it refers to the distinction of *longer* and *shorter* notes or *syllables,* or of longer and shorter *pauses* " (p. 116). These relative durations are recorded as in music ; a semibreve occupying the time of two minims ; a minim representing the duration of two crotchets ; and each crotchet, in turn, being divisible into either two quavers or four semiquavers. By means of such notation, the quantity of each syllable, relative to any other syllable or syllables, can be recorded.

The concept of *emphasis* is less straight-forward, and demands a more detailed discussion, because—unwittingly—Steele uses the term ambiguously, attempting to subsume two quite distinct phenomena under one heading. His transcriptions of stress attributes are largely vitiated as a ́result of this ambiguity. But to understand why Steele went amiss, we must first pause for a brief consideration of his underlying

assumptions about the nature and source of our cognition of time, and the bearing of this upon our perception of the stream of speech sounds.

Steele assumed that we have an inborn tendency to impose temporal order upon the sensations caused by every incoming stream of sounds. This tendency is instinctive, arising from the ever-present throbbing of our blood, which is set in motion by the rhythmical alternation of systole and diastole in the heart. As a necessary consequence, the ragged succession of sounds and silences impinging upon our ears from the external world is perceived as a perfectly regular flow of temporally equidistant cadences or pulsations. " The space of time between each pulsation and the next succeeding pulsation, I have called a CADENCE or *bar* " (p. 116).[5] Cadence is thus a measure of absolute duration, whereas quantity is an indication of the lengths, relative to one another, of the syllabic subdivisions of every bar. But no matter how each cadence is sliced up, its total duration remains unaltered. Steele added that

> " The *instinctive* sense of *pulsation* gives the mind an *idea* of emphasis and *emphatic divisions,* independent of any actual increment of sound, or even of any sound at all. But emphasis and emphatic divisions imply, that there is a discontinuance or diminution of emphasis with or without discontinuance or diminution of sound ; or, in other words, independent of sound " (p. 117).

" Hence," he went on, " we have the mental sensation of *emphatic* and *unemphatic,* which I distinguish and represent by the words . . . *heavy* and *light.* And as a common term to signify both, I appropriate the word POIZE . . . " (p. 117). Heavy emphasis is indicated by a small triangle, light by three dots, and lightest by two dots, placed either over or under the syllable or syllables in question. The rhythmus, or measure of speech, is " the *number* of CADENCES in a line or sentence " (p. 114).

Pause, the fourth of Steele's five speech attributes, was taken into account because, inasmuch as " the affections of *heavy* and *light* . . . are as constantly alternate and periodical as the pulse itself . . . they must be continued, by conception in the mind, during all measured rests or pauses, as well as during the continuance of either uniform, articulated, or modulating sounds " (p. 68). Thus, despite its origin as a reflection of the blood's ebb and flow within the body, emphasis does not correspond to any feature of the physical world, as do our notions of *pause, quantity,* and *accent* (or pitch) ; rather, it belongs to a sphere of immaterial existence. " Cadence itself is an essence, co-existing with articulate sound . . . " (p. 157). This essence, however, determines an important aspect of our perception of speech, for it imposes invariable temporal regularity upon our awareness of sounds.

[5] *After reading Steele's explanation, Lord Monboddo wrote " . . . I am convinced that there is a natural propensity in the human mind to apply number and measure to every thing we hear ; and indeed to every thing, as it is a necessary operation of intellect, being that by which intellect creates to itself its proper objects. For though sense perceives things indiscriminately, and as it were in the lump, intellect apprehends nothing that is not reduced to number, measure, or order of some kind or another. And as this propensity of the mind is previous to any opinion or determination of the will, I think, you properly enough call it* instinctive. *This is undoubtedly the foundation of all rhythm . . . " (p. 94).*

Fig. 1. Mr. Garrick in the Role of Hamlet.

It is now possible to understand where Steele went astray in his attempt to formulate a system for transcribing speech. It was not that he was an inaccurate or careless listener. Far from it. We still accept the doctrine that " In stress languages there is usually a tendency to make the strong stresses follow each other at fairly equal intervals, whenever this can conveniently be done," thus producing "the effect commonly called rhythm . . . in the unconscious endeavour to make the ' stress bar ' equal in length to other ' stress bars ' " (Jones, 1950). Rather, Steele's error lay in elaborating the observed tendency towards rhythmical regularity into a principle from which no perception of an extended utterance was ever believed to deviate, and in denying any external, material, source of the phenomena. Actually, however, we do tend to distribute stresses equally in speaking as well as in hearing, albeit not invariably in either case.

But after pouring all sounds into a mould of periodicity it was hard to record stress phenomena accurately, because " If there be only one note or syllable which fills the whole extent of a cadence, of course, that one note is at first heavy, and then the latter continuance supposed light " (p. 27). Similarly, one heavy—or light—emphasis mark might embrace several syllables. Under these circumstances it was not always possible to show precisely *where* the heavy stress fell. To be sure, the notation of emphasis was designed to serve another purpose altogether. In theory, each heavy-light cluster is an indication of an absolute time-interval. The number of such clusters per minute would be a measure of speech-tempo, although Steele himself does not attempt to correlate them with the absolute intervals marked by a watch or chronometer. Instead, he merely employs musical terms such as *allegro* and *largo* to suggest the tempo of some clauses. The notation is not put to its proper use. But this hardly matters. Steele's major mis-step occurred when he postulated an innate time-sense, and then went on to evolve symbols—the marks of emphasis—that would have to record its supposed operation while, in practice, *also* serving to show the location of word-stress. The impossibility of achieving both goals with only one set of symbols was not recognized in *Prosodia Rationalis*.

Nevertheless, there is a saving grace. *Pauses* are carefully indicated, with the result that heavy emphasis is not necessarily imposed upon syllables where a lighter stress is generally seen to be in order. The innately determined heavy emphasis can be assigned to the moment of silence, thus preserving a rough correspondence between " poize " and stress phenomena, while at the same time, obscuring their differences and allowing an ambiguous terminology to pass unnoticed. However, Steele did observe that by fitting pauses into the framework of the supposed regular periodicity, he was able to record " the natural and necessary *emphasis* (or *poize*) and *quantity* of each syllable," thereby avoiding the errors of those who, neglecting to allow for the possibility of pauses, "frequently misplace the *light* and the *heavy*" (p. 77). It is important to realize, although Steele did not, that in the foregoing statement, *emphasis* is used to mean what we now call stress or prominence—the feature which distinguishes the verb *per'mit* from the noun *'permit* ; whereas elsewhere the same term is used in reference to cadence—the immaterial essence co-existing with articulate sound. Most

frequently, though, the one word refers to both simultaneously. But since pauses were always recorded as they occurred—and sometimes supplied when they did not, one suspects—Steele was, in practice, able to transcribe three suprasegmental aspects of utterances (relative duration, pitch, and clause terminals) without any limitation save that of his own ability to listen accurately. Moreover, insofar as stress is often correlated with relative duration, the longest syllable of each transcribed clause may tentatively be identified as its heaviest stress. Thus the concealed flaw in Steele's system is much less harmful than it might easily have been had he not resorted to what even his staunchest apologist to date has deplored as a " libertine use of pause " (Omond, 1921).

Even though Steele asserted that in the very act of attending to the stream of speech we necessarily impose perfect regularity upon it, he had to admit, inconsistently, that " a bad musician, or a bad speaker, may pronounce so as to keep no certain measure. And a speech written down by the help of our notes, according to the bad manner of such a speaker, would appear to be divided *unrhythmically* ... " (p. 187). This admission shows that Steele was candid enough to look squarely at the disturbing fact that one *does* encounter utterances which decline to be chopped up into equal cadences. The original postulate of inevitable periodicity had to be modified—or else discarded altogether, leaving only pause, pitch, relative duration, degree of loudness, and possibly three degrees of stress. His actual transcription, in fact, certainly comes very close to adopting the second alternative, thanks to the inclusion of pause. But instead of taking the more drastic step, he clung to the notion of temporal regularity, while acknowledging that " we have many examples of bad writers, and bad readers, and bad men, who pay no regard to *accent, quantity, poize,* decency, good order, or common honesty." This testy concession—with its air of petulant rage directed towards anyone unruly enough to contravene his newly announced law describing the measure of speech—betrays Steele's sole lapse from an otherwise utterly dispassionate search for truth. In this matter alone, he closed his eyes to the seemingly disorganized fullness of fact in order to preserve the comfortably neat edifice of his own system, tartly maintaining that " notwithstanding all violences and irregularities, *accent, quantity, poize,* order, decency, and honesty, have still an essential existence, in the language and manners of mankind " (p. 164). The mind, as Dr. Johnson had pointed out not long before Steele penned those words, is fond of its own productions.

Yet the striking quality of Steele's work is not this sole concession to both his own vanity and that search for order which is so characteristic of eighteenth century rationalism. On the contrary, one is struck by the fact that such lapses are, like Desdemona's handkerchief, notably absent most of the time.

The fifth, and final, term adopted by Steele is *force,* or loudness. He was at some pains to explain that " *emphasis of cadence* and the *expression of loudness,* are not to be considered as equivalent terms or affections of the same kind " (p. 12). Lord Monboddo, however, complained that as he was " no musician," he was " not able to make the distinction betwixt *light* and *heavy,* and *loud* and *soft* " (i.e., between stress and loudness) since " as to words," he could not " conceive how the *heavy,* or accented

syllable, as it is commonly called, should be sounded *soft*, or the *light* syllable *loud*," albeit he could " indeed conceive how the whole sentence may be pronounced in a softer or louder voice ; but still the *heavy* syllable will be *louder* than the rest, and the *light, softer* " (p. 60). In other words, his Lordship interpreted stress as a matter of relative loudness. Steele, in order to illustrate the distinction involved, urges us to

" Suppose a man speaking to his mistress in the words " MY DEAR ! " *Dear* being, in this place, put substantively, is absolutely affected to the *heavy*. . . . Suppose the conversation to have begun in the ordinary degree of loudness, and at the instant he pronounced *My*, a person appears in sight, who ought not to hear the next syllable, the speaker can instantly soften his voice, even to a whisper, though still the word will carry its proper emphasis and remain *heavy* " (pp. 88-89).

This example turned the trick, and Lord Monboddo complained no more. If we may take his Lordship's confusion as typical of contemporary thought on this topic, Steele must be given credit as the first to explicitly demonstrate the foregoing distinction. However, there was probably some justification for Lord Monboddo's initial reluctance to accept Steele's assertion that emphasis is entirely distinct from force, inasmuch as " to the hearer, degrees of stress are often perceived as degrees of loudness " (Jones, 1950). On the other hand, it is also true that " a strong stress may occur on a sound incapable of receiving any noticeable increase of loudness " (Jones, 1950). Hence, although Steele clearly recognized the latter possibility, he was perhaps something too positive in ruling out the likelihood of there being more than one explanation for the same phenomenon.

Steele's remarks on the distribution of " the several properties or accidents belonging to language " may be noted now that his five distinguishing terms have been examined.[4]

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[4] *In discussing Steele's formulations it has seemed advisable to avoid, wherever possible, fitting them into the terminological framework of any one particular modern system. There exists at present a diversity of viewpoint and Babel of conflicting terminology, which reflects the fact that our knowledge of the suprasegmentals is still incomplete. Nor are we agreed in our methods of transcribing them. In America they are generally regarded as " secondary " phonemes, and thus distinguished from vowels and consonants, which are " primary " phonemes. Transcriptions take into account open transition, three distinct clause terminals (rising, falling, and suspended), four degrees of stress, and four contrastive levels of pitch—although, as D. L. Bolinger has recently observed with respect to the hypothesis of four significant pitch levels, " There has been no serious attempt to collect a real corpus of examples to test the theory, nor has it been proved experimentally " (1958). In England, on the other hand, only segmental elements of speech are accorded phonemic status, while significant aspects of length, stress, and voice-pitch are variously referred to.*

For the purpose of analyzing Steele's work, Daniel Jones' presentation of the relationship between sound-attributes and phonemes has been taken as a reference point because it offers a useful guide to the borderline separating areas of undisputed fact from regions requiring further investigation in the territory mapped out by Steele. It should be mentioned that Professor Jones draws a distinction between prominence, which " is an effect perceived objectively by

He believed that loudness varies freely with the speaker and " as the nature of the subject in discourse may occasionally require ; and then assuredly it will be applied to whole *words* or *sentences* " (p. 147), whereas " *emphasis* or the heavy *poize* of a syllable . . . is never *ad libitum*, but positively fixed in all words, except monosyllables." The latter may be either light or heavy, save that " . . . the words SOIL, TOIL, and some others seem absolutely heavy " (pp. 165-166). Quantity was regarded as variable, governed in part by the rhythmical measure imposed upon speech ; and intonation was stated to vary " according to the position of words, whether in *question* or in *answer*, in a *suspended* or in a *final sense* " (p. 145). A long list of words is provided in order to illustrate how the various transformations of quantity, pitch, and " emphasis " serve to alter the meaning of words that do not otherwise differ: (to) *in'sult*, for example, is contrasted with (an) *'insult*, and rising pitch is shown to transform a word spoken in isolation from an affirmation to a query. Then Steele observes that

> " In the foregoing list of words it will be seen, that the syllables in some *verbs* are of a different POIZE from the same syllable in the kindred noun. This useful distinction is, I believe, not of very long standing. I remember when it was in fewer words than it is now ; and, I think, it is a good deal in the power of the learned, by art, to make it almost, if not quite, general " (p. 147).

Although this question lies outside the scope of our present study, it would be interesting to know whether the use of stress in making such noun-verb distinctions was actually coming into wider vogue during the course of the eighteenth century, or whether Steele was simply learning to listen more carefully, and observe distinctions that had not occupied the attention of his childhood.[5]

the hearer," and " stress, which is a subjective activity on the part of the speaker" (1950). I have, however, used the term " stress " to embrace the objective as well as the subjective aspects of the phenomenon in question, since it has not seemed necessary for the present study to distinguish the two.

However, it might be advisable to indicate here the relationship between Prosodia Rationalis *and the mid-century American terminology. Steele's pause may be equated with clause terminals, and his indication of rising or falling pitch provides us with two possible directions of the terminal. However, it is not possible to translate his indications of pitch into one or another of the four contrasting phonemic levels postulated by the Smith-Trager school, although in some clauses one could hazard a guess with fair assurance of accuracy ; nor does Steele indicate open transitions, albeit certain small rests might be interpreted as representing, in all likelihood, cases of such juncture rather than clause terminals. Nevertheless, there is no consistent and conscious effort to record juncture separating syllables of one word, or cases of several words being run together. Finally, Steele's transcription of heavy, light, and lightest emphasis is related to stress, although, as explained above, his assumption of temporal regularity very frequently renders any more definite equation of the two terms suspect.*

[5] *In addition to* insult, *Steele's list includes three other noun-verb pairs distinguished by stress :* ac'cent-'accent ; pro'duce-'produce ; *and* pro'ject-'project. *There is also one verb adjective distinction :* (to) fre'quent-'frequent.

CONTEMPORARY RECEPTION, INFLUENCE, AND
SUBSEQUENT REPUTATION OF *PROSODIA RATIONALIS*

Professor Saintsbury, after condemning the " absolutely Bedlamite scansions " and other " atrocities " of *Prosodia Rationalis,* sighed that " The melomania of Steele in prosody was sure to attract followers ; this kind of crankery always does " (1910). Among those misguided disciples we may number Odell, Thelwall, Roe, and Alexander John Ellis. All wrote in the nineteenth century, when, largely as a result of Sir William Jones' accomplishment in directing European attention to Sanscrit, scholarly interest was deflected towards the task of exploiting the newly unfolding " opportunities of surveying a greater and greater linguistic territory " (Pederson, 1931). One consequence was the rise of the neo-grammarian school, with an attendant slackening of activity in the area of Steele's work: it was not until well into the twentieth century that interest again centered on " organisation as opposed to genesis " (Trim, 1959). The problem of describing living speech had been pushed to the periphery of academic attention, although, to be sure, the labourers who did remain in that vineyard were far from inactive. Technological innovations following in the wake of the first industrial revolution had facilitated investigation of speech-physiology, and were soon to provide phoneticians with Mr. Edison's talking machine. But before glancing at the relationship between Steele's pioneering efforts and those developments, let us pause to survey contemporary response to *Prosodia Rationalis.*

Boswell noted in his journal that on Sunday, February 4, 1776, he " had young Donaldson at Tea [and] Got from him Kenrick's review of Steel's [sic] scheme of recording the measure and melody of speech like musick," adding with unwonted brevity that " It struck me a good deal " (1931). That review—unsigned, although possibly by Kenrick himself if Boswell was being specific[6]—appeared in two parts, one in the December 1775, and the other in the January 1776 number of *The London Review of English and Foreign Literature By W. Kenrick and Others.*[7]

First, observing that " a chaunt or brogue is common to provincial dialects and bad orators, while the most elegant and refined speakers have the least of it," the reviewer remarks that " so little have some of our best and most genuine orators of tune in speaking, that we have known very musical ears unable to distinguish it," and admits that " on such authority, we ourselves have heretofore denied the existence of it in polished speech [although] at the same time, we confess ourselves converts to Mr. Steele's proof of its existence." So, it will be recalled, had Lord Monboddo.

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[6] *Yet the review displays a more charitable temper than is usually found in Kenrick's comments on other people's work, and may have been done by his son, William Shakespeare Kenrick, or else contributed by some other hand.*

[7] *I have only been able to see the second part, which, however, expresses the reviewer's judgment of Steele's system, and refers to the first part as " Having given a pretty full and particular account of Mr. Steele's musical scheme, respecting the melody or rise and fall of the voice in speaking." The December issue may, therefore, have largely confined its remarks to explanation, reserving criticism for January.*

However, in this reviewer's opinion, " even admitting that, in the rise and fall of speaking, the voice does run the divisions up and down the very few notes within the compass contended for [,] The oratorical melody of the Greek tongue being confessedly lost, and the application of it, or the substitution of any thing equivalent to the English, being attended with great, if not insuperable difficulties, it may be worth considering, whether it would not be better to give up all thoughts of it entirely, and make the suppression of such variation the distinguishing characteristic of *speaking*, as opposed to *singing*." As he went on, the reviewer became more positive, finally affirming that " tune should be given up entirely to singing, and the abolition of the little musical chaunt there is, in speaking, should be recommended, as best suiting the elegance of speech." Thus, variations of pitch were recognized only for the purpose of putting them in their proper place. If English could not achieve the accomplishments of Greek, it had better give over the attempt altogether. There is no middle ground allowed here : either English has all the properties of a classical tongue, or it has some of them ; in any event, it should not be allowed to wander off on a new pathway of its own making. For the aesthetic satisfaction of maintaining a more pleasing " elegance of speech," intonation was to be censured prescriptively rather than simply studied and described.

Then, after acknowledging himself " particularly pleased with his illustration of, what he calls the *poize*, or *light* and *heavy* modes of emphasis, in contradiction to the *loud* and *soft*," the reviewer states that he regards Steele's " notice of this distinction as the principal improvement he has made in the theory of our English prosody." Next, after softening his proscription of tones by depreciating it as " merely our opinion, as *amousoi*, under correction of the musical among the learned," he continues with a few remarks on " the matter of articulation," about which " we speak with more confidence, having long made it a peculiar branch of our study." He states, " It is so pretty an hypothesis, that there are, as our author maintains, neither more nor less in *nature* than seven vowel sounds, that we are by no means disposed to controvert the truth of it ; though we see no efficient cause in philosophy to confine the organs of articulation to the formation of seven any more than any other number. . . . Of this at least, we are confident, that the actual variation of vowel sounds as they are pronounced in different languages, cannot well be reduced to so small a scale." The review draws to a close after denying that either Steele's distinction between vowel and diphthong[8] or his other " hints respecting the articulation of vowel sounds " are in any way novel, inasmuch as " Dr. Wallis long since pointed out several of them, and other writers have recently pursued the subject much farther." Finally, the reviewer ends by taking issue with several pronunciations that Steele—who was born

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[8] *Steele wrote that, " In order to distinguish what are* VOWELS *and what are not, let this be the definition of a vowel sound ; videlicet, a simple sound capable of being continued invariably the same for a long time (for example, as long as the breath lasts), without any change of the organs ; that is, without any movement of the throat, tongue, lips, or jaws.*

" *But a diphthong sound is made by blending two vowel sounds, by a very quick pronunciation, into one." (p. ix). The distinction was illustrated by several examples.*

in Ireland in 1700—had indicated: speculating " that from a provinciality or other peculiarity of dialect, his ear is not well qualified to judge of articulation," and asking in astonishment " For goodness' sake, how doth he pronounce *nation* to make the first vowel in it shorter than that in *may* and *make* ? "

Two months later, however, an anonymous writer in the March issue of *The Critical Review, or Annals of Literature by A Society of Gentlemen*,[9] who was evidently somewhat out of touch with the latest work in the field, said that Steele's " definition of a vowel is the most precise and complete we have ever met with." He also found Steele's *application* of musical notation to the task of transcribing speech " something new, which has particularly attracted our attention," adding hopefully that " when this art is perfected, and once brought into familiar use, we think it may be possible to convey an oration from one kingdom to another, or hand it down to posterity, in the manner, style, and emphasis of the speaker . . . every word or syllable being marked with the proper measure and inflection of the original expression." Then the reviewer bolstered his own " approbation of this essay . . . by the concurrent opinion of the learned, ingenious, and philosophic author of *The Origin and Progress of Language*, given on this work, in a letter of his to Sir John Pringle, purposely on this subject." His Lordship, " as well as all the musical men " in Edinburgh to whom he had shown it, agreed that *Prosodia Rationalis* was a " most ingenious performance." Moreover, Lord Monboddo viewed the possible utility of Steele's work as hopefully as had the *Critical Review's* man: now that the fact of tonal variation has been demonstrated, he wrote, it " may be improved, by observing and noting what is most excellent of the kind, in the best speakers," so that " both the voice and ear of those who do not speak so well, might be mended, and even the declamation of our best actors, may be improved, by observing in what respects they fall short of, or exceed ; for as soon as a thing is reduced to art, faults will be found in the best performers, that were not before observed." Note that in contrast to the writer in Kenrick's *London Review*, who had argued that Steele's notation could best be used in a campaign to suppress the phenomena which it had been elaborated to describe, *The Critical Review* urges two constructive applications of the new system: improvement of declamation, and its transmission to posterity. However, the reviewer—though not his Lordship, who gives a different opinion, elsewhere[10]—thought that one must be selective, sparing posterity examples of *faulty* declamation:

" The only particular we think reprehensible in Mr. Steele's tract, is his paying so much deference to Mr. Garrick's pronunciation or expression, which judges have often taken to task. A person may be a good actor, who is no critic in language.

[9] *This discussion in the* Critical Review, *a brief notice in the* London Magazine, *and the criticism printed in the* Monthly Review *are not listed by A. G. Kennedy in his* Bibliography of the Writings on the English Language From the Beginning of Printing to the End of 1922 *(Cambridge & New Haven, 1927), and may be added under serial number 7351.*

[10] *Writing to Steele, he urged that both good and bad examples be transcribed, so that posterity might judge whether the arts of oratory, rhetoric, and acting had declined or improved.*

Besides, stage diction is not allowed to be the *jus et norma loquendi* among us, however it may be admitted to that honour in France."

In April, *The London Magazine, or Gentleman's Monthly Intelligencer* took notice of *Prosodia Rationalis,* supplying its readers with three paragraphs from Steele's book, but only advising them that " This essay hath merit, and many of the writer's observations are new and judicious."

In July, *The Monthly Review, or Literary Journal by Several Hands* devoted four pages to a consideration of *Prosodia Rationalis,* citing Dr. Burney's remarks in his *History of Music* " ' giving a place to the *invention of characters* for theatrical *declamation,* among musical *desiderata,*' " because " ' the *notation* of the *tones,* in which a favourite and affecting speech was spoken by a Garrick, or a Cibber, would not only be an excellent lesson to inferior actors ; but would be a means of conveying it to posterity ; who will so frequently meet with their names and eulogiums, in the history of the stage, and be curious to know in what manner they acquired such universal admiration.' " It was the reviewers' opinion that " The speculations of the excellent judge above quoted, on this curious subject, appear to be realised, or at least a laudable attempt is here made for that purpose, by Mr. Steele." Having evidently accepted Steele's suggestion, and patiently struggled with a bass viol, the *Monthly Review's* man reported on " the principle difficulty attending the attempt to put his scheme in execution," remarking that

" Mr. Steele has indeed contrived a good set of symbols, accompanied by ingenious remarks on their use, in which the *rhythmus,* the rests or pauses, the *forte* and *piano,* &c. are sufficiently marked: but how, we would ask, is the just *intonation* to be known, and written down, from the mouth of a speaker, or to be executed on the view of his notes ?—or what ear can be so quick, nice, and discerning, as to keep pace with, discriminate, and ascertain the rapid and evanescent musical *slides* of the human voice, up and down the scale, in common speed, or even in theatrical declamation ; so as to enable a person to mark the limits of each syllable, with regard to gravity and acuteness, and to express them on paper ? The Author indeed allows a latitude in this matter ; but this allowance, in our apprehension, though it lessens, does not by any means remove the difficulty ; as we have found when we have attempted, *viva voce,* to reduce this part of his scheme to practice—even with a violoncello under our hands, as a guide and prompter."

After further discussion of the difficulties involved in transcribing intonations accurately and attempting to read aloud from such transcriptions, the reviewer concludes that Steele " has clearly shown that there is a musical melody in common speech, and that it is formed by slides or fluxions: though we dispute the practicability of ascertaining or even estimating the *pitch,* or extent, of these slides in practice."

This reproach may explain why little more was heard of *Prosodia Rationalis* during the remaining years of the eighteenth century. A second edition, available in 1780, was not, so far as I have been able to determine, discussed in any journal: probably because by then all those interested enough to experiment with Steele's system had encountered the same practical difficulties reported in the *Monthly Review,* and had

regretfully abandoned the task as hopeless. Sounds could not be arrested in mid-air, and flew by too quickly for identification—particularly if one were trying to record *every* variation of tone, no matter how slight. Yet the trouble did not reside primarily in Steele's system. Despite the ambiguous role assigned to emphasis because of a mistaken assumption of temporal regularity, the notation was capable of handling all the non-linear aspects of speech reasonably well, and it might have been refined to suit the needs of narrow transcription once it was realized that the tendency towards rhythmicity operates to alter the duration of utterances as well as to influence our perceptions of sound, albeit in neither case producing absolute regularity. But the human ear was not equal to the task of supplying the necessary information—and neither the phonograph nor the oscillogram were available. One thinks of Leonardo, who might have anticipated the Wright brothers if someone had provided him with an internal combustion engine to use as a starting point.

In any case, it is interesting to note that when the deficiencies of the human ear had been remedied by the invention of mechanical means of arresting sound long enough for repeated observation, work was picked up again at practically the same point that Steele had reached a century and a quarter earlier. In 1909, Daniel Jones published *Intonation Curves : A Collection of Phonetic Texts, in Which Intonation is Marked Throughout by Means of Curved Lines on a Musical Stave*. In it, he stated that for " a complete analysis of pronunciation the following elements of speech must be represented: (i) the quality of the various sounds (ii), the quantity of the sounds (length), (iii) their relative loudness, and (iv) the pitch of the voice in pronouncing them." These requirements of a " complete analysis " are remarkably close to those put forward by Steele, so far as the suprasegmentals are concerned. Stress, or " emphasis," is equated with relative loudness as Lord Monboddo had initially recommended ; the assumption of innately imposed rhythmicity done away with ; and duration indicated by two marks (long and short) instead of notes. But there is essentially no change in the method of transcribing those attributes selected as significant. Although *Prosodia Rationalis* is not mentioned, one could easily imagine that Steele's system has simply been steered towards the goal of broad transcription, while retaining its basic method of indicating tonal variations in conjunction with other attributes. The major change consisted in the means of observing raw data ; for as Professor Jones then explained: " In order to obtain accurate results it is generally necessary to take several observations for the quality of a given sound and several more for its pitch " (1909). But without the aid provided by " a Gramophone, Phonograph, or other similar instrument," such repetitions would be out of the question. Steele—who saw ninety-one winters—did not live to see the talking machine. His ideas were essentially sound, and the climate of opinion was favourable. But technology had not yet proceeded apace. Therefore *Prosodia Rationalis* failed to achieve its purpose, and was practically forgotten.

Of those few who did remember, little need be said about Thelwall, Roe, and Odell. As Omond has remarked, " Their work was little known, their influence small, so it hardly matters where we place them." In their hands, Steele's memory had been carried far off the beaten pathway of linguistic advance. But that cannot be said of

A. J. Ellis, who acknowledged *Prosodia Rationalis* to be " the classical work on the time and cadence of English speech," adding, " I wish to express my own obligations to Steele," and commenting on " the rarity and value of his book " as warrant for giving brief extracts from it together with " transliterations of his symbols," in a lengthy footnote to an article " On the physical constituents of Accent and Emphasis " (1873-1874). In the same place, he wrote that " The next great study of English intonation is that of *James Rush,* M.D., in his ' Philosophy of the Human Voice '. . . . Mr. Melville Bell, in his " Principles of Elocution," has availed himself of their labours and added much of his own. The fact of ordinary change of pitch in English speaking is of great importance for our appreciation of classical accent." Two years later—and precisely a century after the publication of *Prosodia Rationalis*—Ellis remarked

" It will be found not easy to take note of all these peculiarities in reading a piece of poetry. Joshua Steele and James Rush tried much this way, see my paper on Accent and Emphasis, Philological Transactions, 1873-1874, pp. 129-132. Steele attended to length and silence in one, under the name of time, and distributed them so as to divide speech, in prose or verse, into equal intervals of time, answering to musical *bars* ; he especially noted pitch, and also force, not however, as here employed, but as part of expression, and hence forming part of weight, and corresponding to the crescendos and diminuendos of music, and in fact the whole apparatus of oratory. What is here meant by force he calls weight, and makes it agree so completely with the beating of a conductor of music, that he assigns weight to silences " (1876).

It will be observed that Ellis emphasizes Steele's postulate of periodicity, omitting any mention of his independent apparatus for indicating relative duration. The historic importance of *Prosodia Rationalis* is thus pointed out, although the consequences of its underlying flaw are, in effect, allowed to obscure its countervailing virtues, with the result that Steele is in one place praised for having written " the classical work on time," while in another he is implicitly reprimanded for misunderstanding that topic. But, as we have seen, Steele's partially mistaken analysis led, in practice, to transcriptions whose accuracy could hardly be improved upon until more subtle instruments than the human ear were provided for the purpose of gathering data. Once that assistance began to be forthcoming, however, his faults must have loomed larger and larger. The new technology enabled phoneticians to attack an old problem with fresh vigour, and when the pitfalls in the pathway opened by their predecessor became apparent, it appeared most important to warn others of the dangers lying therein. All the advantages of Steele's system would be clear to anyone familiar with the latest work, but the disadvantages had to be spelled out in detail, inasmuch as they might still trap the unwary. Yet when later scholars read Ellis' warning, it must have been natural to conclude that Steele's book, while " classical " in point of priority as a brave though unsuccessful attempt, had little of lasting worth that would recommend it to their attention. Hence, I suggest, it was allowed to pass out of mind.

On the other hand, so far as the prosodists were concerned, the greatest merit of Steele's system rendered it useless for their purpose. Although everyone agrees that

what is not prose is poetry, no one has yet provided a thoroughly satisfactory explanation of the distinction, least of all on the linguistic level. Poetry, of course, has " meter " —or if it does not, then we must call it " prosaic " poetry. However, there is no convincing definition of " meter," which is said to involve temporal regularity by one camp, accentual regularity by an opposing school—and *both* by the fence-sitters. Yet most will agree that some sort of uniformity is an essential ingredient. Moreover, there is fair accord on the question of how particular poems are to be described: Pope used iambic pentameter extensively, while the ballad of *Mary Ambree* is in jolly anapestic tetrameter. We know this because if the poem at issue is chanted in a kind of sing-song manner it becomes evident. But as soon as the poem is read conversationally the phenomenon disappears, leaving only the irregularities of ordinary speech, none of whose attributes can be convincingly correlated with the previously discerned metrical pattern. Yet—say the prosodists—the poetry is distinguished *qua* poetry because the conversational or prose pattern is contrasted in our mind with the " meter." Nevertheless, it is not explained how someone who listens to a poem while it is read aloud in a normal manner, without having previously chanted it or examined it on the printed page, can possibly discern a metrical pattern: he hears only the sound attributes of prose speech, and has no prior memory of a metrically regular pattern with which to compare and contrast the irregular flow of noises aimed at him from the stage or podium. How then, does he respond to the presence of such patterns ? Like the Cheshire cat, they have a disturbing way of vanishing just when everyone wants to have a close look at them.

Steele hoped to solve the riddle by equating meter with temporal periodicity. But since he allowed for pauses, the number of cadences per line could be highly variable throughout any given poem, and although more accurate transcriptions resulted therefrom, the will-o'-the-wisp metrical regularity was nowhere to be found. Consequently the prosodists discovered that his work did not advance their quest, however fine it might be for recording the prose aspects of speech. As Omond put it, " Our word accent, and still more our sentence accent, are too fugitive and capricious to be made the sole basis of verse. If metre depends wholly on them, it becomes a chaos, and prosody is impossible." Moreover, " to suppose that the number of cadences is immaterial cuts away the foundation of prosody. This heresy, as we have seen, originated with Steele himself ; his followers unfortunately adopted it " (Omond, 1921). Hence, by attempting to record what he actually heard, Steele eventually incurred the criticism that, " He seems to recognize no law but his own ear " (Omond, 1921). Thus his chief recommendation as a phonetician led to his dismissal by the prosodists. At best, they recognized in his work a masterful " analysis," but turned away from his results " in disgust."

Perhaps it is now possible to state a more balanced estimation of Steele's position as a linguistic thinker. If the comments of his contemporaries are taken as our guide, Steele's contributions are seen to have been threefold: He was the first to persuade many people that English does have significant tonal variation in everyday speech ; his was the most convincing—and probably the first—illustration that stress is not

necessarily a matter of loudness ; and finally, he was the earliest English phonetician who attempted in a systematic way—and with considerable success—to devise a notation whereby the suprasegmental aspects of speech could be transcribed. Moreover, when his work is regarded in the light of subsequent history, we note that it was not superseded for over a century, while its strong points were recognized, and quietly taken into the main stream of linguistic advance. *Prosodia Rationalis* fell into temporary obscurity primarily because its methods required assistance that was beyond the scope of eighteenth-century technology. If the requisite equipment had been available in 1776, the Royal Society group, then actively corresponding with Sir John Pringle on linguistic issues, might have immediately settled down to the task of applying and refining Joshua Steele's system for transcribing the measure and melody of speech.

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WORD LENGTH AND INTELLIGIBILITY*

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Intelligibility tests were conducted with monosyllabic, bisyllabic and trisyllabic words under conditions of known and unknown message sets. Longer words were found to be more intelligible than shorter words in both known and unknown message sets. Differences in intelligibility among the different lengths are interpreted in terms of acoustic discriminability and relative word frequency.

INTRODUCTION

The present study is an extension of an earlier investigation into the effect of word frequency on the intelligibility of monosyllabic words presented in noise (Pollack, Rubenstein and Decker, 1958). In that study we observed that the frequency with which words occur in the language had a strong effect on their intelligibility when the list of test words was *not* known to the listener (unknown message set) but was without effect when the list of test words was known (known message set). Here we examine the effect of word length on intelligibility under these same two conditions—when the message set is known and when it is unknown.

METHOD

Five university students, serving as a listening crew, were told that they would hear a set of monosyllabic (M) words (or, when appropriate, a set of bisyllabic (B) or trisyllabic (T) words). Each set consisted of 12 words. Each set was presented 6 times under unknown conditions at each of 7 increasingly favourable speech-to-noise (S/N) ratios. Successive steps were spaced 4 db (from −9 to +15 db S/N). The same words were later presented as known sets in S/N steps of 2 db over the range from −15 db to −7 db. The 12 words of each set were selected from four ranges of word frequency (1, 10, 100, 1000 occurrences in 4·5 million words) as established in the
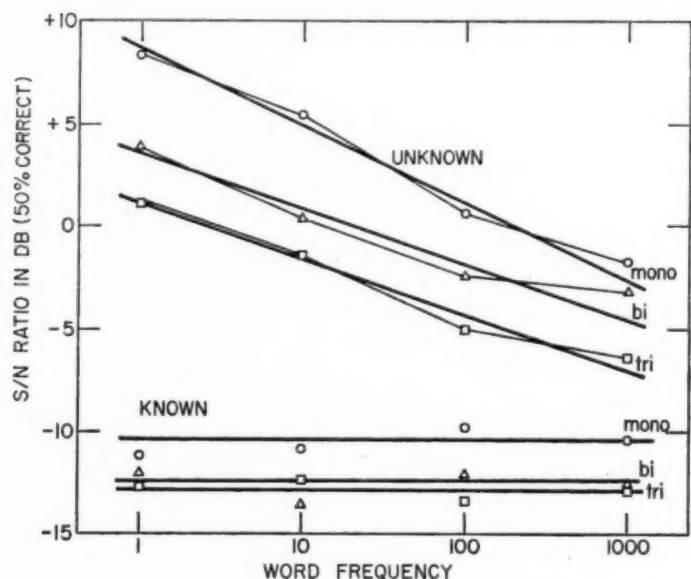
Fig. 1. Word-frequency effects with known and unknown message sets. The ordinate is the S/N ratio required for 50% correct word reproduction ; the abscissa is the frequency of occurrence within the Lorge Magazine Count of 4,500,000 word occurrences. The parameter on the curves is word length. Each point was derived from an articulation gain function based upon 5 listeners, 3 words, 6 replications ; and 5 and 7 S/N ratios with known and unknown sets, respectively.

Lorge Magazine Count (Thorndike and Lorge, 1932). The speech levels refer to monitored VU level readings. The noise levels refer to the overall voltage across the earphones (PDR-8) of a white noise (100-6800 cps) as measured with a Ballantine 300 Voltmeter.

RESULTS

The measure of intelligibility employed is the S/N ratio required for 50% correct reproduction of the presented words. The results of the tests are summarized in Fig. 1. As reported previously, word-frequency effects are observed only in the case of unknown sets, where the average slope is 2·6 db per log (base 10) unit of word frequency. Length effects, on the other hand, are found in both known and unknown sets. In known sets, the mean M – B difference is about 2·0 db and the mean M – T difference about 2·4 db while in unknown sets the mean M – B difference is about 3·5 db and the mean M – T difference about 5·5 db. It is noteworthy that the slopes are roughly parallel indicating an absence of interaction between word-frequency and length effects.

DISCUSSION

It is scarcely surprising to learn that long words are more intelligible than short words. It is reasonable to believe that the longer the word, the more cues, i.e., phonemic differences, are given for its discrimination. Bell (1953) gives us data to support this view. He shows that as word length increases, both the number of potential letter combinations and the number of different words increase but that the former increases far more rapidly. Reasoning quasi-mathematically, we view this as suggesting that as length increases, the acoustic space (delimited by the number of potential phonemic combinations) increases more rapidly than the number of different words it contains so that the distance between words—and hence their discriminability—increases. This may suffice[1] to explain the effect of length in known message sets, but the explanation of the even greater effect of length in unknown message sets requires consideration of still another concomitant of increased length—a decrease in the number of word occurrences. Thus Dewey (Herdan p. 178, Table A, 1956) in analyzing 100,000 words of English text found around 66,600 occurrences of monosyllables, 9,300 occurrences of bisyllables, 3,200 occurrences of trisyllables, etc. This means that given words with the same Thorndike-Lorge frequencies of occurrence, within their respective lengths bisyllables have over 7 times the relative frequency of monosyllables while trisyllables have over 21 times the relative frequency of monosyllables. Howes (1957) has already shown that differences in intelligibility between words of different lengths are related to the log of the ratio of their relative frequencies.

A reasonable hypothesis, then, is that the greater intelligibility of longer words in unknown sets is primarily a function of 1) greater acoustic differences resulting from the increasing ratio of potential phoneme combinations to the number of different words and 2) increasing *relative* word frequency ; and that the effects of these two factors are additive (since Fig. 1 showed no interaction between length and frequency effects). Our data permit a test of this hypothesis.

If our reasoning is correct, we should be able to approximate the differences in intelligibility between lengths in unknown sets by adding the effects of relative frequency ratios to the differences in intelligibility obtained between lengths in known sets (which we assume to be due primarily to acoustic differences). As we have seen, the ratio of the relative frequency of M words to B words is about 7 times or about 0·8 log (base 10) unit, and the ratio of the relative frequency of M words to T words is about 21 times or about 1·3 log units. Since the slopes in Fig. 1 indicate that a log unit change in word frequency produces a change of about 2·6 db in the S/N required for 50% correct response, the relative frequency ratios yield an M – B difference of 2·1 db (0·8 × 2·6) and an M – T difference of 3·4 db (1·3 × 2·6).

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[1] *An alternative explanation might be as follows : assuming the average energy per phoneme to be independent of word length, the proportion of phonemes correctly recognized would be the same in long words and short words. Since, however, there are indications that the average redundancy per phoneme increases with word length, the number of correct word reconstructions would be greater in the case of long words than short words.*

Adding the differences for the known sets to these, we obtain the following estimates for the differences between lengths for the unknown sets: $M - B = 4 \cdot 1$ db $(2 \cdot 1 + 2 \cdot 0)$ and $M - T = 5 \cdot 8$ db $(3 \cdot 4 + 2 \cdot 4)$. These estimates agree quite closely with the obtained mean differences: $M - B = 3 \cdot 5$ db and $M - T = 5 \cdot 5$ db.[2]

CONCLUSION

Longer words are more intelligible in noise than short words in both known and unknown message sets. The obtained differences in intelligibility among long and short words in unknown sets may be approximated from their intelligibilities in known message sets and the relative frequencies of the various word lengths in the language.

[2] *Parenthetically, it may be noted that listeners rarely emit function words such as the, a, and, etc., despite their relatively high frequency in the language. If we disregarded function words (which are predominantly monosyllabic) in determining the frequency of occurrence of the various word lengths, the agreement between the observed and predicted values would be even closer.*

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AGE DIFFERENCES IN THE ABILITY TO USE VISUAL CUES IN AUDITORY COMMUNICATION

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The purpose of the present investigation was to examine whether with age, older workers who suffered from a loss in hearing acuity, developed compensatory skills. Tests of speechreading ability were given to men working in industry and the results examined for any variation in the development of this skill with regard to age, amount of hearing-loss and vocabulary level.

The findings indicate that although hearing losses increase with age, there does not appear to be any incidental acquisition of skill in the use of the visual components of speech as an aid to speech intelligibility. In fact the ability to make use of such cues seems to diminish after the age of about 39, and scores obtained by the over-sixties in a specially constructed speechreading test, fall to approximately half of those made by the thirty to thirty-nine year old subjects.

Vocabulary level appears to influence scores made in the speechreading test. There is also a correlation between vocabulary level and performance on the speech test of hearing ability.

INTRODUCTION

Although it has been known for some considerable time that the use of visual cues brings about an increase in speech intelligibility, relatively little attention has been paid to the part played by visual cues in aiding conversation between individuals with unimpaired hearing. O'Neill (1954), who studied the importance of visual cues when listening to speech under conditions of noise, concluded that " individuals with normal hearing made appreciable use of visual cues (lipreading) to gain information in some communication channels ". Lipreading has been reported in industrial situations by Johnston (1953) and earlier by Weston and Adams (1935). In their investigation of the visual contribution to speech intelligibility in conditions of noise, Sumby and Pollack (1954) used word lists to show that as the signal-to-noise ratio decreased and the signal was masked by noise, visual cues increased in importance. They also showed

the relationship between intelligibility as measured in terms of percentage correct responses and the information content of the signal. Using different test material, Miller, Heise and Lichten (1951) found decrements in performance as the size of the vocabulary used in the tests was extended from 32 to 1,000 words. It is apparent from this work that within a limited informational environment such as a weaving shed, some lipreading skill may be acquired, but because of the restricted nature of the lipreading skill involved (Ewing, 1946), workers in noisy environments would not be expected to attain the degree of proficiency in lipreading which a profoundly deaf person would develop. The term speechreading is used frequently instead of lipreading, since it covers sources of information other than the lips (Pauls, 1947).

It appears reasonable to suppose that those who spend a considerable proportion of their lives in conditions which make communication difficult would acquire some skill in speechreading. Similarly, if there is an increase in deafness with age, whether it is attributed to " internal noise " (Gregory and Wallace, 1958, p. 83) or whether it is merely an attenuation of the incoming signal because of middle-ear conditions, it may be expected that an ' average ' gain in ability to use visual cues would occur as age and deafness increase. From clinical observation, Saltzman (1957) suggests that phenomenal speechreaders predominate in congenital and postmeningitis deafness and that they are found only infrequently in cases of deafness due to otosclerosis, Ménière's disease, presbyacusis and arteriosclerosis.

Since the number of cases of reported deafness increases with age (Wilkins, 1949, p. 7 and Best, 1943, p. 81) it would seem probable that speechreading ability would be acquired incidentally as a compensatory skill even though phenomenally good speech-readers would not be expected. The unconscious use of compensatory skills has in fact been reported by Kodicek and Garrad (1955) who observed that although many older patients said that they did not lipread, they could not continue the interview if they were unable to see the speaker's lips.

The importance of the visual speech components is no doubt attributable to their complementary nature. Those consonants which have been shown by Fletcher (1953) to have a low sensation level (and which because of their high-frequency composition would be heard less well by older subjects with high tone deafness) are fairly easy to detect visually. Neely (1956) found that the use of such visual cues in an auditory test in which he used males with normal hearing, brought about an improvement in scores amounting to twenty per cent.

For those with normal hearing as well as those who are deaf, there are apparently marked individual differences in the ability to speechread. Utley (1946) carried out tests on 761 subjects but was unable to correlate speechreading skill with such variables as age of persons tested, onset of deafness or school achievement and Keaster (1955) also found large individual differences in tests carried out on 40 college students with normal hearing.

The ability to receive and interpret visual cues as an aid in communication with another person is apparently dependent on many factors and it is difficult to attribute good speechreading to any one in particular. Because of these wide differences it was

decided that tests would be given to a " normal " population with the aim of obtaining data on at least some of the variables which were thought to be important.

Aims of the Investigation
1. To examine a " normal " population for the development of compensatory visual skills as age and hearing losses increased.
2. To relate success in speechreading, where possible, to other variables.
3. To examine age differences in ability to handle auditory and visual information in the various test situations.

Population selected[2]
This consisted of 180 male employees of a large modern factory in which many different occupations were represented. The tests were carried out in the medical department of the factory and for all cases, full occupational and medical histories were available. Data were also available concerning such other variables as noise-level and the spectral composition of the noise in which some of the subjects normally worked. This factory is located in the north-west of England, a region for which Wilkins gives figures showing that the incidence of reported deafness is double that of the south of England. One man did not complete all the tests, so that his results were not used in the final analysis ; therefore the data presented in this paper refer to 179 cases. The age-structure of this sample is shown in Fig. 1.

The solid bars indicate the percentage number of subjects at each of the five age-levels and for comparison, the hollow bars show the percentage age-distribution of men in the population from which the sample was obtained. The number of men tested in each of the five age-groups is indicated by the figure above each solid bar.

Tests in order of presentation
1. Pure-tone audiogram.
2. A test of hearing ability for speech using sentences.
3. A vocabulary-level test (Mill Hill Senior Synonyms).
4. A silent ciné-film test of speechreading ability.

Further details of above tests and comments
Test 1. Audiograms were obtained for both left and right ears at frequencies of 125, 250, 500 c.p.s. and 1, 2, 4, 5, 6, 8 and 10 Kc/s.
Test 2. On the basis of the audiograms obtained in the previous test, the better ear was selected for the speech test of hearing. Sentences based on the sentence lists of
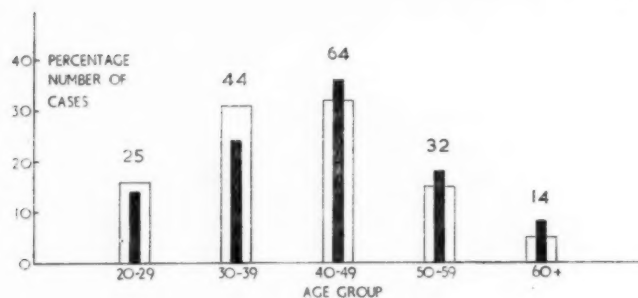
Fig. 1. Percentage age distribution.

Fry and Kerridge (1939) and recorded at the G.P.O. Research Station (Medical Research Council Committee on Electro-Acoustics, 1953) were obtained on tape and presented at various intensity-levels to each subject monaurally. From the articulation-curve produced by plotting percentage scores against intensity-level, the intensity-level corresponding to a 40% correct score was determined for each individual (Knight and Littler, 1953, p. 263). This value in decibels is relative to that obtained by a control group of 23-25 year old subjects tested under the same conditions. Hearing losses for speech are, in all cases, relative to this group.

Sentence lists were chosen instead of lists of words or nonsense syllables because from a practical point of view they give more information about an individual's ability to interpret in a meaningful way the speech signals which he receives. It has been pointed out by Dickson *et al.* (1946, p. 179) that when meaningful words are used "the sounds are attached to the linguistic framework of the listener's language and the personal differences between listeners, differences for example in their vocabulary or in their quickness of wit, become more important and have a greater effect on the results of the test". Since it was desired to investigate these differences, sentence lists were included in the test programme rather than tests using other material.

Test 3. This test was given without a time limit: all subjects were literate.

Test 4. The writer was unable to trace a ciné-film test of speechreading ability of the kind required, so one was specially constructed.

Since it had been shown by Sumby and Pollack (1954) that "the relative visual informational contribution supplied by observing a speaker's facial and lip movements is *independent* of the speech-to-noise ratio under test" a silent ciné-film was chosen as a valid means of testing speechreading ability. Using a technique of this kind, the auditory component is completely absent and the measures taken therefore record the

contribution of visual cues to speech intelligibility uncontaminated by auditory factors.

This silent ciné-film test was recorded in monochrome using 16 mm. negative stock. The first part of the film consists of a list of 50 numbers spoken by a girl with 6 second pauses between each number. Practice items are included before the test commences in order to familiarise subjects with the procedure. Subjects are required to call out what they think the numbers are but are not asked to record their responses on paper ; this is done during individual testing by the experimenter. Scoring forms have, however, been prepared for group administration and the test has been devised to enable it to be given to groups of subjects as well as individually (Farrimond, 1959). In this part of the test the only information which the subject receives consists of visual cues from the head and neck of the girl reading out the numbers. The subjects' scores on this task are influenced only by the visual components of the speech pattern and not by the probability structure of the situation. No additional information is available which may suggest to the subject that one number is more likely to occur than any other.

The second half of the test was designed to provide this additional information. By using lists of sentences and preceding each sentence by a short scene of some appropriate activity, the subject's response is now determined not only by his ability to utilise the information from the facial movements of the sentence-reader, but by his accuracy of prediction of the sentence most likely to occur in relation to the scene previously shown.

Fairly simple activities were chosen for this part of the film, for example, one scene depicts a man tying his shoelace ; another shows an angler fishing in a lake. In each case, the degree of relevance of the sentence to its preceding scene has been adjusted so that some sentences are more difficult than others. To take the first example given above of a man tying his shoelace. If this is followed by a sentence such as " He maintains his equilibrium ", it is obviously going to be more difficult than a straight-forward sentence like " The man ties his shoelace ".

The visual patterns with the exception of the last word are similar in both sentences, but the probability of occurrence of one is higher than that of the other within that situation.

There are 25 items in the sentence test and the subject is asked to say what he thinks the girl has said about each scene. Individual verbal responses were also recorded in this case, but by adapting the procedure slightly, this part of the test may also be administered to groups. There are 100 scorable words in the sentences test so that percentage scores are obtained directly.

RESULTS

Test 1 (pure-tone audiogram). Composite pure-tone audiograms for the five age-groups are shown in Fig. 2.

The general trend is similar to that reported by Hinchcliffe (1958, 1959) and shows
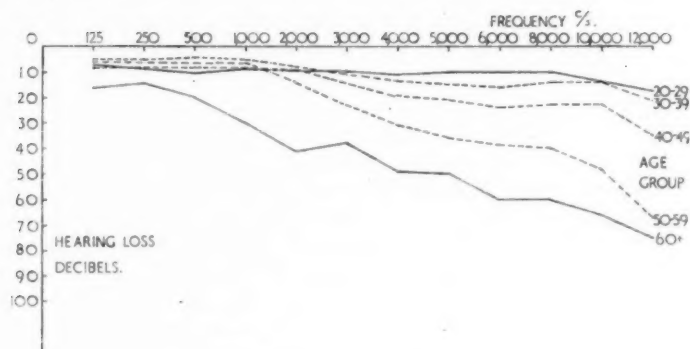
Fig. 2. Composite pure-tone audiogram: left ear.
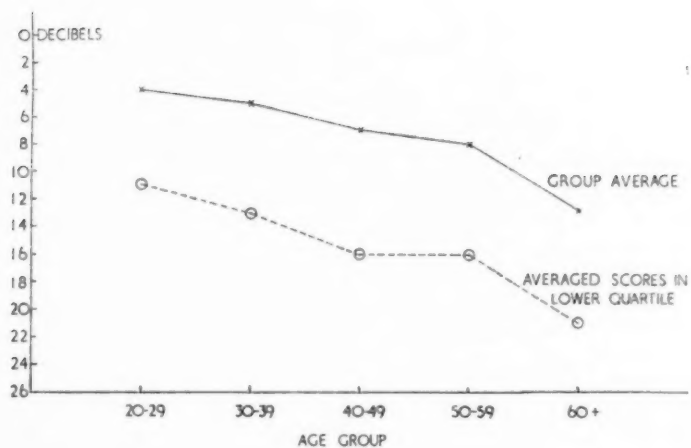
Fig. 3. Hearing losses for speech.
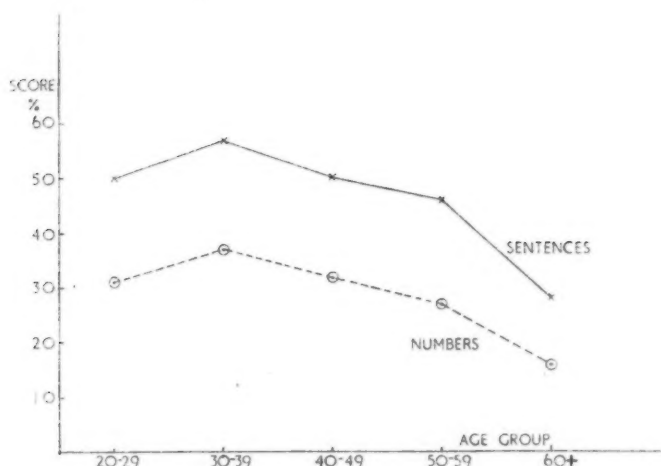
Fig. 4. Lipreading skill and age.

a decline in hearing acuity with age for the high frequency tones.

Test 2 (speech audiogram). The averaged hearing losses for speech (solid line) for the same age-groups are shown in Fig. 3.

The lower broken-line represents the averaged hearing losses for speech for those whose scores fell in the lower quartile. It may be seen that those men with the poorest hearing, have average losses of from 11 to 21 decibels. Many individuals, however, had hearing losses of greater than 30 decibels and in one case there was a loss of 63 decibels. These losses are for the better ear in each case, so that in some directional listening situations when sound impinges upon the poorer ear, the magnitude of the handicap would be in excess of that indicated by the figures previously quoted. As an example of the effect of such hearing losses on an individual in a practical situation, when listening to average speech (which is usually of the order of 60 decibels) a person with 30 decibels hearing loss would hear the speech as little more than a whisper and with a loss of 60 decibels he would hear practically nothing at all.

Test 4 (speechreading ability). The results of the speechreading test are shown graphically in Fig. 4.

The scores obtained on the sentences test are shown by the solid line, those on the numbers test by the broken line. Performance at speechreading is maximal for the 30-39 year age-group and then progressively declines as age increases. The two curves exhibit similar characteristics, one difference being that the scores obtained in the numbers test are approximately half those obtained when sentences were used. (This
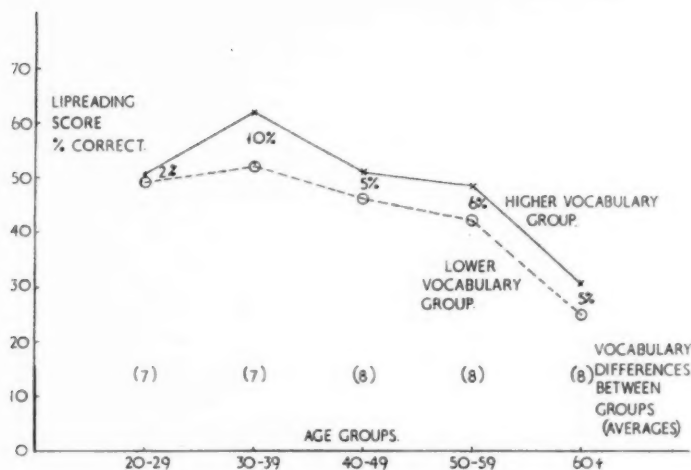
Fig. 5. Vocabulary level and lipreading ability (sentences).

difference is probably a function of the different degree of contextual information in the two tests.)

Tests 3 and 4 (vocabulary level and speechreading ability—sentences). To obtain information on the influence of vocabulary-level on speechreading ability the individuals who had been tested were divided into two approximately equal groups. Those with above average scores on the vocabulary test were placed in one group (the upper group): those with below average scores were placed in the other group (the lower group). This was done throughout the age-range and speechreading scores for the two groups are shown plotted against age in Fig. 5.

It may be seen that speechreading scores are slightly higher at all age-levels for those in the higher vocabulary group (shown as solid line) as compared with the lower vocabulary level group (broken line). The differences in terms of percentage scores are indicated by the figures between the two graphs: average vocabulary-level differences between the groups are shown by the figures beneath the broken-line graph. Correlations between the four tests and age are presented in Table 1.

If vocabulary-level and hearing ability were the only factors involved for success at speechreading, then it would be expected that if older men were matched for these variables with a group of younger men, they should perform equally well at speechreading. Two such groups were formed: pure-tone audiograms for thirty men aged

TABLE 1

	1 Age	2 Loss for Speech (dbs)	3 Vocabulary	4 Lipreading Sentences	5 Lipreading Numbers
1	—	—	—	—	—
2	+0·33	—	—	—	—
3	−0·17	−0·26	—	—	—
4	−0·27	−0·29	+0·34	—	—
5	−0·37	−0·22	+0·33	+0·74	—

TABLE 2

	FREQUENCIES IN CYCLES/SEC.			
	500	1000	2000	4000
Average Hearing Loss in dbs for the Younger Men	7·1	8·6	13·3	26·0
Average Hearing Loss in dbs. for the Older Men	7·6	8·8	14·0	31·5

TABLE 3

1	Age held constant	Vocabulary Level and Speechreading Ability (Sentences)	+0·31*
2	,, ,, ,,	,, ,, ,, ,, ,, (Numbers)	+0·29*
3	Vocabulary held constant	Age and Speechreading Ability (Sentences)	−0·23*
4	,, ,, ,,	,, ,, ,, ,, (Numbers)	−0·34*

* Significant at 0·01 level.

between 20 and 29 years were examined and matched individually as closely as possible with the pure-tone audiograms of thirty 50-74 year old men for frequencies which were regarded as being of most importance for the reception of speech (Quiggle *et al.*, 1957). The averaged pure-tone losses for the two groups are shown in Table 2, and the average vocabulary score obtained by the group of younger men was 29·0 words

correct as compared with 28·2 words correct for the older men. Even though the two groups were similar with regard to vocabulary level and hearing ability, the younger men obtained an average score of 54·5% on the speechreading test, as compared with 41·2% scored by the older men. Partial correlations obtained on the whole sample of 179 cases for age, vocabulary level and speechreading ability for numbers and sentences, are shown in Table 3.

Visual acuity factors are probably not of great importance in influencing performance on the speechreading tests. Subjects of all ages had passed the visual tests normally administered by the factory authorities and subjects wore their glasses during the tests. It is proposed, however, to administer further tests of visual acuity, one of which is a visual acuity test involving a time factor.

DISCUSSION

From Fig. 3 which shows the decline with age of hearing acuity for speech, it is apparent that there are some individuals, particularly in the older age-groups, who have quite large hearing losses. On this basis and from what has already been stated concerning the ways in which visual cues are used in conditions of noise, it would seem reasonable to expect a nett gain in ability to speechread among the older men. This does not in fact occur and after the peak performance has been reached at 30-39 years of age, scores on the speechreading tests fall fairly steadily by about 8% per decade so that it appears quite clear that compensatory visual skills are not developed by the older men in order to offset their auditory deficiencies; at least not for hearing losses of this order of magnitude. It seems probable that hearing tends to be relied on unless the losses exceed a certain critical amount. This is in fact similar to the situation referred to by Saltzman in which really good lipreaders were most often found among post-meningitis cases and cases of congenital deafness. It seems that if deafness occurs slowly over a period of years or is of a moderate degree of severity, then the old, firmly established listening habits are relied on and even though such persons may *make use* of visual cues when conversing with some individuals whose speech is difficult to hear, they do not, without specific training, acquire greater skill in the interpretation of these visual cues. It may be that the older men with hearing defects may pay more attention to lip movements and facial expression when listening to speech and that the decline in ability as indicated by the speechreading test is due to ageing of the central processes involved in this activity. This line of argument is probably correct and it would be interesting to compare these findings with data obtained from a sample of good speechreaders with a test of speechreading ability given to the same subjects at ages of 40, 50 and 60 years. Possibly the performance of skilled speechreaders would show little change with age and this function may be found to " hold up " as is the case for vocabulary level tests which show little decline with age. In the case of the subjects tested in this sample, the necessity for complete reliance upon speechreading as a sole means of communication has not occurred and consequently the skill is not developed and stabilised. Instead, what appears to happen is that whatever skill each individual may possess at speechreading, remains without further development and as age increases, the facility for transforming visual speech patterns into their auditory equivalents diminishes. The process of speechreading involves a form of statistical correlation between a visual pattern and an auditory pattern, the number of possible alternatives from which the selection is to be made being limited by the presence of any contextual information. In the case of the film, this information was provided by the scene preceding the sentence. The degree of specificity of the sentence to the scene partly determines its difficulty; the other factor is the " readability " or otherwise of the sentence from a speechreading standpoint.

In the previous description of the speechreading film, it has been pointed out that some scenes contain a certain amount of irrelevant and sometimes misleading information. The responses of the older men indicate that it is more difficult for them to

perform rapidly the sifting and selecting operations which are required for the pairing of the visual and auditory patterns. The choice is made on: —

(a) the information obtained from the scene—objects, persons, actions, etc. ·
(b) the pattern of responses in previous items in the test. (Position in the series would be expected to play a part here.)
(c) the visual pattern which is to be " lipread ".

The first important factor which each subject makes use of is probably the contextual information which limits the number of possibilities. Certain words or phrases may be anticipated on the basis of this information and the various auditory possibilities " tried out " for a best fit between them and the lip-movement pattern.

The three main components involved appear to be context, visual pattern presented by the lip-movements and auditory pattern. For a hearing person the visual pattern which he observes is only a representation of the auditory pattern, in which the auditory component is of the greater importance. A direct lip-pattern language does not exist as it does for a congenitally deaf person who lipreads. For those cases with some hearing, the situation is analogous to that of a man whose native language is English who is learning French. In the early stages, the French words are transformed into English words before any sense can be made of them. Later, when the French words and the objects and actions which they symbolise have been directly linked by experience, the intermediate use of English is not necessary. The symbols serve for the concepts which they identify and one can " think in French ".

The process of transformation by judicious selection for the older speechreader is the most probable source of difficulty and in many ways may be likened to the difficulties which older persons experience in concept formation tests, as described by Bromley (1956) for example in the Shaw Test, where selection within various frames of reference is attempted using objects which must be grouped in many different ways. In this case, however, for the combination of the blocks in the test on the basis of different principles, it is necessary for the subject to draw upon a considerable amount of information in order to relate under one unifying concept the five different stimuli as represented by the blocks. The process of relating each separate block with some common element (e.g. colour, weight, size, etc.) represents in a more complex form the process involved in speechreading. It is scarcely surprising to find that the ability to form concepts in this test diminishes quite rapidly as age increases. The true ageing difficulty appears to be one of decreased central efficiency in these " correlational " processes. Selection and decision speeds are reduced (Crossman and Szafran, 1956) and the greater the number of selection functions which are called upon in a particular situation the more difficult does the task become for the older man. Speechreading appears to be intermediate in terms of difficulty between tasks such as interpreting speech under threshold listening conditions and conceptualisation in tests such as the Shaw Test.

Referring to the partial correlations between age and speechreading ability in Table 3, it is interesting to note that the numbers part of the test gives a higher negative correlation with age than the sentences test. This may be because the older men are

enabled, because of the additional information in the sentences test, to maintain their performance, whereas in the numbers test age differences in ability to utilise the visual speech patterns can not be compensated for by reliance upon other cues. The need for older subjects to have stronger signals on which to act has been noted by Welford (1958, p. 284) and it was found by Weston (1949) that increased illumination assisted older subjects in a visual task more than younger subjects, even though they were comparable in terms of visual acuity. Apparently increased signal strength may be analagous in its effect to an increase in available information in the sentences test of speechreading ability.

Hearing Ability for Speech, Vocabulary Level and Speechreading Ability

From Fig. 5 it was seen that for all age groups, the average speechreading scores are higher for the higher vocabulary-level subjects and that both curves show approximately the same rate of decline with age. Vocabulary level correlates with speechreading ability and also with hearing ability for speech (Tables 1 and 3). It is suggested that this is due to the similar functions demanded in both situations. The ease with which a visual pattern, as perceived by the subject, is transformed into its auditory equivalent, is related to the speed and efficiency with which the subject is able to run through a number of alternatives: then on the basis of the information obtained from (a) the lips of the speaker, (b) contextual cues derived from the scene and (c) his own store of probabilities based on past experience, he selects the most appropriate verbal response. The task in the speech-hearing test is similar in some respects, the subject must listen at threshold-level to sentences of which some of the information content is lost. The subject is again in the position of having to base his response on the contextual cues provided by words which may have been recognised in the sentence and upon his experience of the probability of occurrence of words within a particular frame of reference. The lower the signal-level, the more the response is determined by subjective experiential factors. The better the ability of the subject to manipulate language rapidly, the higher would seem to be the probability of a correct response on the basis of incomplete information. Vocabulary level is apparently at least a partial index of this ability.

In speechreading, some individuals perform much better than others of the same age, even though they appear to be similar in terms of intellectual level, hearing ability and general industrial experience. Possibly these individual differences may be related to speech-habit patterns acquired in infancy. Children who observed the lip-movements and facial expressions of their parents in imitating speech may have continued to do so in later life, whereas children who relied solely on auditory signals would not be expected to develop visual-hearing habits. This is of course speculative.

CONCLUSIONS

1. Ability to speechread is maximal for the 30-39 year old men. Scores then decline by approximately eight per cent per decade, probably as a result of central age-related changes.

2. Hearing losses of the order of magnitude found in the sample do not appear to lead to the incidental development of compensatory visual skills as measured by a speechreading test. Any tendency to develop speechreading skill in order to offset the effects of presbyacusia is more than balanced by the decline in ability to deal with information of this kind. It is probable that much greater hearing losses would be required before any substantial improvement in speechreading ability was found.

3. Because of the apparent decline in the ability to make use of visual cues after about the age of thirty-nine years, it would seem advisable in cases where deafness is progressive and unlikely to be alleviated by surgical means or the use of a hearing-aid, to commence instruction in speechreading as early as possible. It is emphasised that the differences observed between the various age-groups do not result from differing rates in ability to *learn* speechreading but from changes in efficiency in dealing with visual information which is available. Learning rates are probably affected adversely by ageing (Kay, 1951) and this again would indicate early training in speechreading in certain cases. There are reasons for supposing that once speechreading skill has been acquired, it may be expected to be retained in later life: this seems to be a property of some human abilities, particularly in the case of communicative skills such as spoken language.

4. Vocabulary level appears to have some bearing on the ability to handle language and translate visual into auditory information. Both the speechreading test and the test of hearing ability for speech show a correlation with vocabulary level. The influence of vocabulary level on hearing-ability for speech is a significant factor if equipment is to be standardised for speech audiometry. If a population is selected which has a higher-than-average vocabulary level, although this may not be important in the case of the establishment of pure-tone norms, it would lead to the production of a speech threshold which would be too severe for general use.

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THE SOCIAL AND THE INDIVIDUAL IN LANGUAGE

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The behaviourist view of language, which reduces it to a system of stimuli and responses, is too limited, since it leaves out of account the function of apprehension (prise de conscience). Language embodying socially accumulated and generalised experience reflects the phenomena of the surrounding world in the human mind in the form of consciousness. Thus, consciousness is a form of reflection which is social by nature. It is inconceivable without the mastery of language.

At the same time " speech capacity ", i.e. the mastery of language, is determined by inborn psycho-physiological mechanisms common to all human beings. The relation between language as a social and a psychological phenomenon is dynamic, revealing itself in mutual transformations. Individual language is not an " imprint " of the objective system, as F. de Saussure believed it to be, but a product of its active reconstruction.

To analyse this relation it is necessary to investigate the process of transformation of the objective phenomena of social language into individual, and that of the transformation of individual-psychological formations into phenomena of social consciousness. The process of mastery of language is important because the only real existence of language not only as a form of individual consciousness but also as a form of social consciousness is its existence in the minds of real individuals.

These transformations are due to the fact that the laws which govern the phenomena change just as the laws change when phenomena studied by one science are transformed into phenomena studied by another.

The problem dealt with in the present article does not enjoy wide popularity in present-day Western linguistics. This is quite natural, since " descriptive linguistics ", which goes back to the ideas of Bloomfield, and all of their modifications are based on the behavourist psychology according to which human speech consciousness does not differ essentially from the " consciousness " of animals, and like the latter, is reduced to a mere system of stimuli-responses. " For our purposes, then, a human being is an animal, partly like and partly unlike other animals, but unique among all animals in the possession of speech ; our mathematico-mechanical model is intended to account only for this single uniqueness." (Hockett, 1955, p. 3.)

It is evident that such an approach to the nature of language denying the existence of any specific features in human consciousness limits the consideration of the question concerning the " social " and the " individual " in language to the investigation of formal relationships—similarities, distinctions and various reciprocal influences—between separate speech systems.

This state of affairs does not suit the American linguists themselves. For example, as far back as 1953, Weinreich in his review of Carroll's book, " The Study of Language ", expressed the hope that " perhaps more of us linguists ... will some day come to view speech as a meaningful communicative activity and not merely as the production of a corpus for formal analysis " (Weinreich, 1953, p. 279).

Together with Weinreich, we cannot agree with the behavourist interpretation of the nature of language and human consciousness.

The function of language is much broader than communication alone or even thought alone. It is at the same time a function of apprehension (prise de conscience), i.e., reflection of objective reality which is, so to speak, refracted through the prism of socially accumulated and generalized experience embodied in language. The reflection of phenomena of the surrounding world in the human mind in the form of consciousness is an act of language. Already at an early stage, when the child begins to master language, any phenomenon of the language which it encounters during intercourse with the adult calls forth the need to apprehend this phenomenon. For example, when the child hears the word " clock " as applied to an alarm-clock, and then the same word as applied to a tower-clock, this application of one and the same word to two objects differing in their sensual attributes means for the child the necessity of ascertaining and apprehending similar features in the two objects. Man does not merely " embody " in words certain *a priori notions* ; to him words are first of all a means of mastering socially accumulated knowledge and concepts.[1] Thus, consciousness is a form of reflection which is social by nature. It is impossible in a human being isolated from society, from any communication with other people. It is inconceivable without the mastery of language.

But this is not all. Language is not only a social phenomenon ; the biological and psychological organization of man harbours a number of possibilities which determine his mastery of the language as a socially created product and the use of language for communicative and expressive purposes. We can, therefore, join Professor Firth in his view that language is, on the one hand, " a result of nurture " when " traditional systems or habits of speech are learnt and maintained by social activity ", and that, on the other hand, language is " a natural tendency ", so that " language and personality partake of both *nature* and *nurture* and are the expression of both " (Firth, 1957, pp. 185-187).

Thus, language is a form of existence of social, specifically human, consciousness. Not being inborn itself, " speech capacity ", i.e., the mastery of language, is, nevertheless, determined by inborn psychophysiological mechanisms common to all human beings. An individual system of language, as " idiolect ", is not self-sufficing, since the possibility of communication is determined by the existence of an objective system of language. At the same time, however, this individual system of language is not an " imprint " of the objective system, as F. de Saussure believed it to be, but a product of its active creative reconstruction.

THE CORRELATION OF THE SOCIAL AND THE INDIVIDUAL IN LANGUAGE

Let us turn now to our basic question—to the correlation of the social and the individual principles in language, or to be more precise, in speech activity. The correlation between language as a social phenomenon and language as a psychological

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[1] " *You weave* nurture *into* nature, *and you do this with the most powerful magic—speech* " (*J. R. Firth, Papers in Linguistics, 1934-1951, London*).

phenomenon is a dynamic one which reveals itself in mutual transformations of these phenomena. To analyse this correlation, it is therefore necessary first of all to investigate the actual process of the transformation of the objective phenomena of language into individual, psychological phenomena, and, on the other hand, the process of the transformation of phenomena arising as individual-psychological formations into phenomena of social consciousness.

The laws governing these mutual transformations reflect the general laws of the development of society, of the individuals who constitute it, as well as of social and individual consciousness ; it is these laws which we must consider first of all.

In the course of its entire history mankind has developed tremendous spiritual powers and abilities. The successes attained in the development of human abilities and faculties have steadily accumulated, passing from one generation to another. In the era of the domination of social laws, i.e., after the appearance of Homo sapiens,[1] these achievements were being consolidated not in the form of hereditary biologically fixed mechanisms, not in the form of morphological changes, but in a peculiar, external *object* form.

This new form of accumulation of phylogenetic experience proved possible in man owing to the fact that specifically human activity, unlike the activity of animals, is of a productive character. Such is, above all, the basic, *labour* activity of man.

In the process of production (both material and spiritual) labour becomes objectivized in its product. The process of the conversion of labour from a form of activity into a form of being can be regarded from two points of view: either from the point of view of the quantity of labour in relation to the quantity of the product obtained, i.e., abstracted from the actual process of labour, as is done in political economy ; or from the point of view of the essence of labour activity and in relation to the producing individuals, i.e., abstracted from all other aspects and relationships. The aforementioned conversion will then appear to us as a process of embodiment or objectivization of the physical and spiritual abilities of men in the products of their activity and the history of material culture will appear as a process which reflects in an external object form the successes attained by the human race in the development of its abilities. From this point of view, each step forward in the perfection and refinement, for example, of the means and instruments of production, may be regarded as a factor expressing and consolidating a definite stage in the development of the functions performed by the human hand ; the progress of art may be regarded as an expression of mankind's aesthetic development, and so on.

It should be particularly stressed that here we have in mind human mental abilities. Although the whole complex of abilities which man brings into use in the process of labour and which is objectivized in the product of his labour, indispensably includes

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[1] *We base ourselves on the theory advanced by the Soviet anthropologist Y. Y. Roginsky who regards the transition from primitive man (neanderthaloid) to modern man as a qualitative leap, and believes that this turning point " conforms to . . . the establishment of comple: , undivided and final dominion of social laws in the life of man "* (Y. Y. Roginsky and M. G. Levin, Fundamentals of Anthropology, *Moscow, 1955, p. 317*).

also his physical powers and abilities, still the latter only serve to realize the spiritual side of man's labour activity, or its psychological content.

The faculties and abilities of the human race which are expressed in an object form belong to the specific attributes of man.

A species is not merely a group of plants or animals which possess common biological features. According to Komarov (1944, p. 207), " without heredity there would be no species. All individuals related to a definite species belong to this species precisely because they are connected by a complex of certain common characteristics inherited from a common ancestor." The nature of separate individuals depends on the species to which they belong and reflects the progress attained at a definite stage of phylogenetic development. These individuals reproduce in their development the characteristics of the whole species engendered in the course of biological evolution.

A human being, as a representative of the family *homo sapiens,* reflects in his individual attributes and abilities the nature of the species to which he belongs. But the socially and historically developed attributes of man, as distinct from animals, are consolidated not in the form of morphological, i.e., biologically fixed changes, but in a peculiar, external object form. In other words, the specific attributes of man appear in the form of the socio-historical experience of mankind embodied in objective phenomena.

By their activity animals only adapt themselves to environment ; they never master the achievements of phylogenetic development. These achievements are already *present* in the animal in its natural, hereditary abilities ; to man, however, they *appear* in the shape of objective phenomena of the surrounding world. To realize these achievements in the course of his ontogenetic development man must indispensably master them ; only as a result of this active process can an individual embody truly human nature, i.e., all the attributes and abilities which are the product of man's development. This is possible precisely because human attributes and abilities assume an object form.

The spiritual, mental development of human individuals is due to this peculiar process—the process of appropriation which does not exist in animals at all, any more than the opposite process of objectivizing abilities in the products of activity. It is owing to this process of appropriation that the individual reproduces historically developed attributes and abilities (Marx, 1844).

Already at the very early stages of his development a human individual perceives object reality through his inter-relations with surrounding people and, consequently, not only in respect of its material properties and biological meaning, but also as a world of objects whose objective-social significance is revealed to him by man's activity.

It is precisely this that forms the initial basis of the mastery of language and of speech intercourse. Language generalizes the socio-historical experience of mankind and passes it on to separate individuals ; consequently, it is a condition which ensures the appropriation of mankind's socio-historical experience by individuals, and a form of its existence in their consciousness.

Like all human creations, language passes from one generation to another. It may be said that each generation " inherits " language as the product of development of

all preceding generations, just as in the animal world each subsequent generation of the given species inherits the biological features which were acquired in the course of phylogenesis. In this respect there is *no fundamental difference* between language and other products of human activity. If we consider the history of material and spiritual culture from the point of view of the process of objectivizing the historical development of man's mental abilities, it is clear that the development of phonetics likewise embodies the evolution of the articulatory abilities and of speech audition ; similarly, the evolution of the vocabulary and grammar reflects the historical development of the cognitive abilities of man, just as, for example, the complication of the instruments of labour reflects the evolution of the psychomotor functions of the hand. The distinctive feature here is that language, like all other products of *spiritual* culture, exists not only in the form of phenomena which are perceived sensually, but is at the same time a reflection of reality.

THE SIGNIFICANCE OF THE INDIVIDUAL'S MASTERY OF LANGUAGE

Each generation and each individual belonging to the given generation *appropriates* language, or, using a more habitual term, masters it. To the individual language becomes a means of communication, as well as a means of thought and apprehension of reality.

Man begins to master language in early childhood, this process being naturally subordinated to the laws of mental development, i.e., *psychological* laws. In the course of the individual's development this mastery becomes more and more complete, but it never embraces the whole language which exists objectively as a social phenomenon. The evolution of this mastery has been quite profoundly investigated and the laws by which it is governed are now well-known. Suffice it to say that it is always characterized by *electivity ;* this means that separate individuals, groups of individuals and whole generations master in the language only that which conforms and within such limits as conform to their needs for communication, and not only for communication but also for thought, apprehension and other forms of conscious activity.

The elective approach of individuals, groups of individuals and generations to language as a socio-historical category must be particularly stressed because this process is accompanied by a change in language which is negative in form: some of its elements are not adopted by subsequent generations, fall out of use and thus cease to be phenomena of real language.

The process of mastery is, evidently, not indifferent to the given language as a social phenomenon: it is at the same time a condition for the development of the language in its afore-mentioned negative form. If, however, we take into account that any new generation mastering the given language simultaneously adopts the neologisms which appeared in the speech of the preceding generation, we may say that the process of mastery is a condition for the development of language in general, i.e., in all of its forms.

Why does the process of mastery exert such marked influence on language ? The latter begins its real existence only when it has been mastered by concrete people.

Prior to the appearance of written language the only form of existence of language was undoubtedly its existence in the minds of individuals.

It is true that when expressed in a written or printed form the product of speech activity is separated from the speaking individuals ; it appears in a form which is, as it were, excluded from communication. But even this form, as a phenomenon of language, exists only when it has been read, mastered, i.e., when it has become a psychological phenomenon. " As to written language, here communication proves to be disrupted by the space of time which elapses between the process of writing and the process of reading what has been written down. It may be said that the act of speech terminates here when the written text has been read " (Smirnitsky, 1957, p. 11).

The only real existence of language not only as a form of individual consciousness but also as a form of social consciousness is its existence in the minds of real individuals, just as " human thought exists only as individual thought of many milliards of past, present and future men " (Engels, 1934, p. 72).

Thus, the existence and development of language as a social phenomenon is indispensably conditioned by the process of permanent transformation of the objective phenomena of language into individual, psychological phenomena. In this connection it must be particularly stressed that here we have in mind the phenomena of language proper, i.e., the phenomena of language as a system of generalizations. Precisely this process lies at the base of the process of mastery by single individuals of the achievements gained by all preceding generations in the course of historical development ; it is a form of their social " inheritance ". The specific feature which distinguishes the mastery of language from the mastery of other elements of mankind's socio-historical experience consists in the fact that language is a means of communication, a form of existence of the aforesaid experience.

THE INTERRELATION OF THE INDIVIDUAL-PSYCHOLOGICAL AND OBJECTIVE SOCIAL PHENOMENA OF SPEECH ACTIVITY

The process of the mastery of language by single individuals and whole generations constitutes, however, only one side of the mutual transformations which we are considering here. Their second side, which is of particular importance from the linguistic point of view, is the process of transformation of the phenomena of language, as individual-psychological phenomena, into objective phenomena, phenomena of language proper.

Individuals use language not only in their intercourse, but in their entire mental activity. Language participates in the processes of cognition, just as it does in human intercourse : it shapes the individual's thought or fixes it for him. Language also contributes to the apprehension of emotional experience by way of its signification, to the inclusion of the content memorized into corresponding word-connections for the purpose of retaining it in the memory, etc.

In this activity—which is sometimes included in direct intercourse and sometimes not—the already mastered elements of language may undergo certain changes. If such individual changes subsequently enter human intercourse they form the material which

lies at the base of the further evolution of language as a social phenomenon. When they become widespread, i.e., when they are generally used, they turn into phenomena of social consciousness, into objective facts of language. As stated by Sapir (1921, p. 165), " what significant changes take place in it (i.e. language) must exist, to begin with, as individual variations."

This proposition, repeatedly stressed in linguistics, does not require here any special analysis. It is the following question which is of prime importance : What is responsible for the transformation of phenomena of one quality into phenomena of another, new quality ?

Such transformation, as well as the transformation of one form of motion of matter into another, and, generally, of phenomena studied by one science into phenomena studied by another one, are due to the fact that the laws which govern these phenomena change. In view of this, the process of such transformation must be regarded as the result of subordination of the given phenomena to new laws.

When a new phenomenon appears in a language (a new word, a new meaning of an already existing word, a new grammar form, etc.), and when this phenomenon enters human intercourse, its final adoption or non-adoption by the given language depends on whether the bulk of people who speak this language really need such a change. Numerous micro-changes taking place in individual " languages " are subjected, as it were, to natural selection : some of them enter the given language, others do not.

Let us now try to elucidate the laws which govern this " natural selection " of micro-changes in language. With this aim in view, we must, first of all, strictly determine the different levels of the phenomena of speech activity which require different aspects of abstraction.

From the point of view of the problem which we consider here the social level, or the level of social consciousness, is of greatest importance. Laws governing the objective reality of society, determining its general requirements and conforming to the given stage of its development are in operation on this level. Here we consider language in abstraction from its concrete form ; in the words of Firth (1957, p. 180), it " comprises the linguistic tendencies of the general human faculty " ; it is regarded as a function of the human race. On this level any concrete individual appears as a possessor of specifically human consciousness, irrespective of the form of language in which this consciousness manifests itself. An Indian of the Hopi tribe, for example, when perceiving water in a glass and water in a lake, denominates it with the help of two different words ; this, however, does not prevent him from realizing that if the water contained in the glass is poured out into the lake, there will take place no mixture of two different substances.

The second level is the level of language proper. On this level it is the inner laws of language which are in operation. Here language is considered by us in all of its diverse forms ; it is a function of a " speech-community ", each individual being a member of this " community ".

Finally, the third level is the individual-psychological level. In other words, here the psycho-physiological, " biophysical " aspect of language comes to the fore, and

language enters the system of mental phenomena. On this level the individual appears as a concrete individual in the full sense of the word, as a personality who possesses physiological and psychological features common to all mankind, but taken in ontogenesis, in abstraction from their socio-historical significance ; in view of this, one may speak of " individual systems of language ", but at the same time must not, of course, disregard their social conditionality. The " speech " of de Saussure by no means exhausts this aspect of language.[2]

The first, highest level of abstraction is simultaneously the basic level. The laws operating on this level embody the motive forces of the development of language ; these objective laws directly govern the life of society, and indirectly the development of social consciousness. They alone determine the progress of language, exerting influence on its content. But how does this process continue ?

The system of language keeps relative " equilibrium ". But owing to the changing objective conditions which determine the functioning of the language, i.e., to changes taking place on the level of consciousness, the system of language which yesterday successfully served the given society, or the given social group, today proves to be too narrow: it becomes necessary to modify it, to adapt it to the new expressive requirements. Hence, its inner reconstruction ; if the inner " equilibrium " of the language is violated, it recovers at the expense of other elements of the system. On the other hand, the law-governed evolution of the speech organs, which is common to the whole of mankind and which has been demonstrated with regard to the prehistoric era[3] likewise finds an indirect expression in the modification of the system of concrete language and calls forth processes which are usually regarded as " spon-

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[2] *It must be noted that our interpretation of the propositions advanced by F. de Saussure somewhat differs from the traditional interpretation and approximates to that of J. Firth. It seems to us that according to Saussure's viewpoint, language (langue) bears simultaneously a social and individual character. On the one hand, it is " ... la partie sociale du langage, extérieure à l'individu ", and, on the other hand, " un système grammatical existant virtuellement dans chaque cerveau ". As to speech (parole) it is individual only ; it realizes the mental side of language, " l'image acoustique ", in de Saussure's terminology. On the other hand, speech activity (langage) is connected with the social aspect of language ; it is a complex of speech as a material substratum and language as an immaterial principle which organizes the speech substratum : " c'est la langue qui fait l'unité du langage ".*

To de Saussure speech is first of all the material aspect of speech activity, while language is its ideal aspect. Of course, " en séparant la langue de la parole ... on sépare du même coup ce qui est social de ce qui est individuel ", but the " language-speech " relation in no way coincides with the " social-individual " relation, as is generally assumed, since speech embodies the individual principle only inasmuch as it is organized by language taken in its psychophysiological aspect ; otherwise, it loses its inner unity. (Quotations from F. de Saussure, Cours de linguistique générale. *Paris, 1922, 2nd ed., pp. 27-31).*

[3] *Interesting considerations relating to this question may be found in a very rare article of the great Russian linguist I. A. Baudouin de Courtenay :* " Concerning One of the Aspects of Gradual Humanization of Language in the Field of Pronunciation in Connection with Anthropology " (*Year-Book of the Russian Anthropologist Society at the Petersburg University, issue I, 1905, as well as a special reprint) and in his book* " Vermenschlichung der Sprache " (*Hamburg, 1893*).

taneous ". Practically, this modification proceeds as an inclusion into the system of the language, as an objectivization, of individual neologisms.

The laws operating on the social level are external laws in relation to the system of language. The internal laws of the language are, in their turn, rooted in the relations which arise on the second level, i.e., on the level of language proper, as well as in the contradictions which result from the destructive action of the higher level on the system of laws and which must be inevitably solved.

Thus, the evolution of language takes place on all the three levels. Neologisms which originate and function according to the laws of the lower level, i.e., according to psychological laws, become included into the system of the second level and occupy a certain place in this system in accordance with the laws operating at the given level, provided the laws of the higher, social level require such inclusion.

Of considerable interest in this connection are some of the propositions advanced by Shcherba. As far back as 1931 he wrote: "... The changes which take place in language manifest themselves in speech activity. But which factors determine this activity ? On the one hand, a single system of language ... realized in individual speech systems, on the other—the content of life of the given social group. Anything which is truly individual, which does not ensue from the system of language and does not exist in it potentially, perishes irretrievably, meeting with no response and even with no understanding. Under these conditions the unity of content ensures the unity of language ...

" But any slightest change in content ... is immediately reflected in a change of the speech activity of the given group ... Speech activity, which simultaneously serves as material for language, reflects the change of the system of language " (Shcherba, 1956, p. 256).

Any creative change introduced into the language by an individual is directly governed first of all by the laws of mental activity, or *psychological* laws. But when the given change is realized in human intercourse and when the question arises whether it will become widespread, acquire social significance, and thus turn into an objective fact of language, the solution of this question depends on quite different, and by no means psychological, laws. It depends on objective laws which operate on the higher, social level.

We have to lay special stress on the proposition concerning the changes which take place in the nature of laws operating both in the sphere of phenomena of language as individual-psychological phenomena, and in the sphere of the same phenomena as objective social phenomena ; we do it because up to now linguistics and psychology have not attached due importance to this proposition. Moreover, a number of linguists have ignored it in principle.

As we have already mentioned, Saussure regards the individual-psychological existence of language as an " acoustic image ", as a passive reflection of the system of language which exists objectively and prevails over separate individuals, and not as a product of the invariably active, motivated and elective process of mastery. Incomprehension of the real essence of the interrelations and mutual transformations

of the phenomena of language as individual-psychological phenomena, and as social objective phenomena, reduction of the processes going on within the language to intra-systemic processes made de Saussure believe that the evolution of language is fully immanent.

THE CONTENT OF LANGUAGE AND THE PROCESS OF DEVELOPMENT

In order to give a fuller idea of our interpretation of the evolution of language, we shall draw an analogy between the fate of language and the fate of the concrete content it conveys, for example, of scientific and technical thought. Such thought may be expressed and conveyed to another person, and still remain a fact of individual and not social consciousness. It may, however, happen that it will exert objective influence on the life of society, for example, on the development of science ; then it becomes a social phenomenon, i.e., acquires social significance. A thought expressed by an inventor of genius may remain an individual-psychological fact if there are no objective conditions for its application in practice ; in such cases people say that the inventor " is before his time ".

The process of conversion of thought from a fact of individual consciousness into a fact of social consciousness is, however, not identical with the process of conversion of a phenomenon of language from an individual-psychological into a social phenomenon ; it is only analogous to this process.

When we deal with a phenomenon of language, it arises as a result of abstraction of the form of language from the content which is conveyed by it. Let us take, for example, the word " stushévatsa " (" to retire to the background ") introduced by F. M. Dostoyevsky into the Russian language. It could, of course, appear exclusively in connection with a certain *concrete content ;* however, it entered the language not in conformity with its initial content, not as a quotation from Dostoyevsky, but as a form denoting abstraction from the concrete content.

On the other hand, when thought is converted from a fact of individual-psychological consciousness into a fact of social consciousness, there appears an indifference to the form in which it is conveyed. For example, a certain idea turns into a socially widespread notion not in a concrete form of language, but irrespective of it, i.e., in abstraction from this form. One and the same thought may be expressed with equal success in different languages, and within one and the same language, by different means.

From the point of view of our problem, however, it is the first process which is of prime importance ; it is the process of abstraction of the form of language, abstraction of language from the concrete content which is expressed and conveyed in it and whose development, in the final analysis, determines the development of the phenomena of language themselves. Indeed, language *first of all* appears as a means and form which expresses and conveys the content of thought. Subsequently, it may objectively acquire its own logic of development and subjectively become an object of thought.

an object of cognition. In ontogenesis it first appears to the child from the aspect of its content, and certain work of abstraction and generalization is required before the child itself masters the forms of language. Initially this generalization is expressed in the development of a " sense of language " in the child ; later it may become the object of his thought or apprehension.

The process of biological changeability may serve as another analogy. The presence of biological changes does not yet determine the process of biological evolution ; this process is indispensably connected with the operation of the laws of adaptation, the laws of selection of these changes. The latter alone do not constitute the process of evolution ; they provide only the material which is utilized by the aforesaid process.

Although language is above all a social phenomenon, it becomes also a psychological phenomenon when it is mastered by the individual. This very process of mastery is simultaneously the process of transformation of an objective social phenomenon into an individual-psychological one. On the other hand, any phenomenon of language results from the mental activity of concrete individuals and can arise and exist exclusively within this activity.

Thus, language can be rightfully regarded both as a phenomenon of social consciousness and as a phenomenon of individual consciousness or as a psychological phenomenon. At the same time it should not be forgotten that the development and functioning of language is subordinated to different laws, and any attempt to present language as an abstract one-level system is of highly questionable value.

We believe that a profound analysis is necessary to get a fuller idea of the life of language as an objective social system of phenomena. This analysis must include the micro-changes which take place when language exists in the minds of people in the form of phenomena resulting from the mastery by single individuals of the socially created and objectively existing reality of language ; it is also necessary to investigate the conditions under which these changes become widespread in human intercourse and are objectivized producing so-called " spontaneous " changes, i.e., such as do not directly ensue from the systemic laws of language. It is precisely these " extrasystemic " elements violating the systemic " equilibrium " of language, which are the immediate cause of the " drift of language ".

One of the most important tasks of linguistics is to study the " individual system of language ", i.e., to find out how the socially determined, social system of language becomes, so to speak, refracted and incarnated in the consciousness of concrete individuals.[4]

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[4] *See also A. N. Leontiev* " The Historical Principle of Psychology " in " Psychological Science in the U.S.S.R.", *collection of articles, vol. I, Moscow, 1959 ; A. N. Leontiev and A. A. Leontiev* " The Double Aspect of Phenomena of Language " ; in " Papers of the Higher School. Philosophical Sciences ", *1959, No. 2.*

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TOWARD THE QUANTIFICATION OF PHONIC
INTERFERENCE*

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This paper suggests a method for measuring the degree of interference that takes place in the speech of bilingual subjects. The technique is adapted from previous studies on the reception of speech in noise and is used in the first instance to measure interference at the phonic level. Various types of interference are examined and measured in a pilot experiment.

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Recent studies have provided a framework for the description of interference in the speech of bilinguals.[1] This framework provides for interference on a number of levels, phonic, grammatical and lexical, and in two directions, either on the secondary language, or, more rarely, on the primary. It is apparent that, in addition, this interference differs in degree from one speaker to another, or for the same speaker, from one time to another, or perhaps from one level to another. In short, it should be possible to quantify the phenomena which are included in a ' bilingual description.'

The present paper suggests a model which may prove useful for the quantification of interference on the phonological level. The model is a modification of a design described by James Egan and his associates (1955, 1957).

We distinguish four types of *communication events*. ' A communication event refers to the transmission of a message from a talker (the source) to a listener (the receiver) followed by the return of a message (correct or incorrect) from the receiver to the source for confirmation. Although both source and receiver serve successively as talker and listener, the relation between them is asymmetric. Since the source already knows the original message, he must accept or reject the message sent back to him. . . . Various types of communication events arise depending upon (1) whether or not the

[1] *See, for example, Weinreich, U., On the description of phonic interference, Word, 13, 1 - 11 (1957) and works by Weinreich and Haugen referred to in that article ; we adopt much of Weinreich's terminology and symbolization.*

receiver correctly hears the message, and (2) whether or not the source confirms the message sent back to him by the receiver. A capital letter stands for a message and the arrow indicates the direction of the message flow. The division of the types of events ... begins with the simple dichotomy established by whether or not the receiver correctly hears the message. If the receiver hears the message correctly, it is symbolized A → A. If the message is incorrectly heard by the receiver, it is designated by: A → B. ... It is assumed that the message recorded by the receiver is sent back by him to the source ' (Egan *et al.*, 1955). The source may then confirm or reject. A confirmation is symbolized A ← A or A ← B ; a rejection by B ← A or B ← B. The four types of events may be represented schematically as follows :

COMMUNICATION EVENT	SOURCE		RECEIVER	DESCRIPTION OF EVENT
1	A	→	A	Correct Confirmation
	A	←	A	
2	A	→	B	Correct Rejection
	B	←	B	
3	A	→	A	Incorrect Rejection
	B	←	A	
4	A	→	B	Incorrect Confirmation
	A	←	B	

One of the variables Egan is concerned with is the effect of noise on the relative probability of each type of event. In our modification either the source or the receiver is a bilingual, the other a monolingual. The noise is the interference from the primary phonemic system on the secondary.[2] For example, let the source be a speaker of P-Spanish (i.e. his primary language is Spanish), and the receiver a native speaker of English and let the messages be English. Spanish has no contrast between /b/ and /v/ whereas English does. Asked to send the message *vest*, let us assume that the P-Spanish source pronounces [best]. The English receiver interprets this as *best*. He then pronounces [best] which the Spanish speaker, let us suppose, confirms ('Yes, that's the message I sent '). This 'over-and-back' procedure constitutes one event, in this case an incorrect confirmation A → B A ← B where A = *vest* and B = *best*.[3]

Weinreich has proposed four main types of phonic interference : (1) under-differentiation (2) over-differentiation (3) re-interpretation (4) phone substitution.[4] As he points out, the second of these is not always noticeable ; indeed it is not clear

[2] *In Egan's model, the noise is known ; in our model, we try to infer something about the noise (= interference) by observing the communication events.*

[3] *It is clear that the message is the intended message, whatever the phonetic version of this message may be.*

[4] Languages in contact (*New York, 1953*) *p. 18 - 19. In the later article, Weinreich adds the dichotomy between paradigmatic and syntagmatic interference.*

how it can be demonstrated nor to what extent it may rightly be called interference in any strict sense, since the perception of allophonic differences presumably does not diminish communication and may not even be manifested in any 'foreign accent.'[5] However, the other three categories should be demonstrable and a model such as the above provides a way for indicating the amount of interference for each type of phonological difference.

In the proposed experimental design, the source (whether a monolingual or a bilingual) is presented with a list of words as follows:

1) vest   YES   NO
2) pin   YES   NO
3) peas   YES   NO, etc.

The receiver with a corresponding list:

1) best   vest
2) bin   pin
3) peace   peas

The source is instructed to pronounce the word and to indicate by circling Yes or No whether the message he hears for confirmation is the same one he sent. The receiver is asked to circle the message he hears and to repeat it for confirmation. The pairs are chosen to represent different phonological phenomena. Where English is secondary and Spanish primary, the main types of interference are under-differentiation (*best-vest ; seen-sin ; peace-peas*) and phone substitution (*pin-bin ; time-dime ; come-gum*). For a language with no s/z contrast but with phonemic vowel length, *peace-peas* becomes, theoretically at least, an example of re-interpretation, that is, the allophonic lengthening of the vowel before voiced consonants is perceived as distinctive instead of the voicing of the final consonant.

Assuming that interference is measured by the proportion of communication events which are not correct confirmations, a number of general hypotheses suggest themselves: (1) Phone substitution will result in less interference than re-interpretation, and re-interpretation in less interference than under-differentiation.[6] A Spanish speaker substituting unaspirated [t-] for aspirated [tʰ-] in *time* is still maintaining the contrast between voiced and voiceless which is distinctive. At the other extreme, maximum interference should be present where for a Spanish speaker *best* and *vest* turn out

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[5] *Weinreich, Word, 13, 6, suggests that even under-differentiation may result in perfect renditions of one member of an opposition. However, the point is that over-differentiation may result in consistently perfect renditions of both members of an opposition.*

[6] *The most general way of expressing this hypothesis is merely that different phonological phenomena will result in different probabilities for each of the four communication events. For example, best-vest and seen-sin represent different aspects of under-differentiation. Spanish has a [b] but no [v], so that, theoretically at least, best may result in 100% correct confirmations and vest in 0% correct confirmations, that is, the pattern of communication events would be different for each member of the pair ; incidentally, the results of the pilot study do not confirm this hypothesis. On the other hand, Spanish has neither the [I] of sin nor the [Ii] of seen, but 'something in between', so that conceivably the pattern of communication events for seen and sin would be roughly the same.*

to be homonyms. Re-interpretation is somewhere in between. The bilingual is perceiving and producing a difference, but it is a redundant rather than a distinctive one. (2) The ability to perceive precedes the ability to produce new phonemic contrasts. Certain communication events result from mistakes in perception only and certain communication events result from mistakes in production only. For example, if the bilingual is the source, incorrect rejections, that is, events

Bilingual		Monolingual
A	→	A
B	←	A

are due to a mistake in perception by the bilingual since his production resulted in correct recognition. If he is the source, correct rejections, that is, events

Bilingual		Monolingual
A	→	B
A	←	B

presumably involve a mistake in his production, since he correctly perceived the monolingual's message. Thus, we hypothesize that events involving mistakes of perception (incorrect rejections when the bilingual is the source and correct rejections when the bilingual is the receiver) will be fewer than events involving mistakes of production (incorrect rejections when the bilingual is the receiver and correct rejections when the bilingual is the source).[7]

The following are the results of a pilot study involving six pairs of subjects and is merely meant to be illustrative of the procedure and its potential application. The bilinguals were P-Spanish. The pairs of words used were *seen-sin, berry-very, peace-peas,* representing under-differentiation ; *pin-bin, time-dime,* representing phone substitution ; and *rope-robe,* representing a difference in distribution rather than inventory, Spanish having a p/b contrast, limited however to syllable-initial position. Each subject served both as source and receiver ; each of the twelve words was presented ten times in random order so that there were a total of 1440 communication events.

The results for each word of each type of event are shown in Table 1.

In general, hypothesis one above is confirmed ; phone substitution results in less interference than under-differentiation. Hypothesis two is not confirmed ; there seems to be no difference between perceptual and productive errors. Also, there seems to be no difference between phone substitution (*pin-bin*) vs. difference in distribution (*rope-robe*).[8]

There is one important difference of some theoretical interest between the model as originally used by Egan and as modified for the purpose of quantifying phonic

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[7] *Our terms perception/production are roughly equivalent to Weinreich's analysis/rendition.*

[8] *In view of the small number of subjects, no tests of significance were calculated. Furthermore, it became apparent that the subjects in the pilot study were not ideally chosen. The monolinguals were phonetically too sophisticated and the bilinguals knew more English than would be desirable. Both of these factors result in a higher percentage of correct confirmations.*

TABLE 1

I. UNDER-DIFFERENTIATION

		Br	Bs
	CC	90	92
	IC	3	3
seen	CR	2	5
	IR	5	—
		80	93
		17	—
sin		—	2
		3	5
		77	95
		5	—
berry		13	3
		5	2
		92	95
		—	2
very		3	—
		5	3
		63	75
		27	20
peace		—	2
		10	3
		50	58
		17	27
peas		18	12
		15	3
TOTAL		75·4	84.7
		11·5	8·7
		6·0	4·0
		7·2	2·7

GRAND TOTAL:

Br		Bs
84·0	CC	90·3
6·9	IC	5·7
4·8	CR	2·3
4·3	IR	1·8

II. PHONE SUBSTITUTION

		Br	Bs
	CC	93	95
	IC	—	2
pin	CR	—	3
	IR	7	—
		83	96
		5	2
bin		10	—
		2	2
		100	100
		—	—
time		—	—
		—	—
		100	100
		—	—
dime		—	—
		—	—
TOTAL		94·0	97·8
		1·3	1·0
		2·5	0·8
		2·3	0·5

III. DISTRIBUTION

	Br	Bs
	95	90
rope	2	10
	3	—
	—	—
	85	95
	7	2
robe	8	—
	—	3
TOTAL	90·0	92·5
	4·5	6·0
	5·5	—
	—	1·5

Percentages of different communication events.

(Br = bilingual receiver ; Bs = bilingual source ; CC = correct confirmation ;
IC = incorrect confirmation ; CR = correct rejection ; IR = incorrect rejection.)

interference. The difference is essentially the possible introduction of a learning factor during the course of the experiment in the bilingual situation which is absent in the other. In other words, when the ' noise ' consists of a P-Spanish phonemic system on a set of S-English messages, there is nothing to prevent the monolingual from allowing for this possibility and compensating for it. The extreme example would be the case where there is re-interpretation by the bilingual, say *peace-peas* are perceived and produced as /piys/ and /piy's/, and where the monolingual now ' learns ' that length is being used, and confirms (or repeats) accordingly. To investigate this possibility, the data were divided in half, since if there were learning going on, there would be a significantly higher proportion of correct confirmations in the second half than in the first. The data did not substantiate this view, but it is clear that such a possibility exists.

Besides the method's main function which is to provide experimental confirmation in quantitative terms of the validity of ' bilingual descriptions ', it serves as a kind of ' test ' which may be used either as a measure of achievement or diagnostically since it provides data relevant to statements like ' Speaker A has more of an accent than B ' or ' Contrast X is more difficult to learn than Y (for speakers of some P-language) ' or ' Speaker A's pronunciation has improved a great deal.'

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DEFINING LINEAR CONTEXT TO RESOLVE LEXICAL AMBIGUITY*

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This paper sets out a mechanical procedure for eliminating ambiguities in machine translation in cases where a word in the source language has a number of equivalents in the target language. The procedure depends on the inspection of linear word context and the establishing of "diagnostic environments" for the ambiguous words. In the experiment described, the context was restricted to one word before and one following the ambiguous word. It demonstrated that considerable reduction in the number of ambiguities can be achieved by the procedure and that the word following the ambiguous word is more effective than the word preceding in resolving the ambiguity.

INTRODUCTION

In a previous paper, we gave a brief description of the field of machine translation, and attempted to throw some light on the problem of dictionary size (Koutsoudas, 1957). In the present paper we shall be concerned with the question of the extent to which lexical ambiguity can be resolved by the inspection of linear context. For our experiment, "linear context" was limited to an environment of one word before and one word after an ambiguous word.

The problem can be stated as follows: how, when a source language presents us with a word which has several possible translations, are we to choose the contextually appropriate equivalent for it in the target language ? [1] So far, scholars interested in machine translation have proposed two different solutions. The first, supported by E. Reifler at the University of Washington and A. G. Oettinger at Harvard, involves reproducing in the output of the machine all the possible meanings of each multiple meaning word. Given this material, a human "post-editor", familiar with the subject-matter and the target language, can be set to choose the proper equivalent. It can be argued for this method that it does away with the need for multiple meaning analysis, for "look-up" operations, and for some machine subroutines and programming, and thus minimizes machine time. Furthermore, it is generally agreed that

[1] Idiomatic expressions constitute a special case of the multiple meaning problem and are not treated in this paper. The problem of identifying Russian words ending -o/i-e/-ee and functioning as adverbial modifiers or predicative complements has been dealt with in a previous study and has not been considered here. See A. Koutsoudas and A. Humecky, Ambiguity of Syntactic Function Resolved by Linear Context, Word, Vol. 13, No. 3, December 1957.

machine translation will be realized for one limited universe at a time (e.g. scientific texts) and not for " language " as a whole. In such a limited universe, lexical ambiguity tends to be restricted in two ways. There are often fewer possible translations for any given multiple meaning word, and multiple meaning words themselves are fewer. Consequently, the number of choices which the post-editor is required to make is relatively low.

In spite of this, however, the method seems to have serious limitations. In an experiment performed at the University of Michigan, it was found that machine translation with subsequent post-editing is actually slower than human translation. Worse still, a person who is familiar with the subject-matter but not with the source language will often find difficulty in doing the post-editing, and may even produce a readable and sensible " translation " which in fact contains serious distortions of the original text.

A second solution, supported by D. G. Hays at the RAND Corporation and the author, rests on an appeal to immediate context. That is, given a text in the source language, and a word within the text which has more than one English equivalent, our aim is to provide the machine—not a " post-editor "—with a set of rules which will enable it to determine the appropriate translation of this word by inspection of its context. Now plainly we can only formulate such a set of rules if we know, for each multiple meaning word, the *diagnostic environments,* that is, (1) the *classes* of words and/or punctuation marks which determine the selection of the correct translation for each situation in which the word occurs, and (2) the *positioning,* with regard to the multiple meaning word, of the elements of these classes.

Consider, for example, the Russian preposition " za " with " for " as one of its English equivalents.[2] Suppose that on taking a large text and analyzing the context of each occurrence of " za ", we find that the selection of " for " as the appropriate equivalent is directly dependent on the presence of certain other Russian words, such as " stoyat' ", " otvetit' ", " prinyat' ", etc.[3] We can now group all these latter words into a " class 1 " (the symbol is irrelevant), and we can instruct the computer, on finding " za ", to select the equivalent " for " if, and only if, there exists a member of class 1 in the given context.

Suppose now, that having determined the relevant classes (1, 2, 3, ... , n) of diagnostic words for each translation of " za ", we group these classes into the larger class W. Suppose also that investigation reveals regularities in the positioning of the members of class W ; that, for example, in 87% of the cases they precede " za " by two words, in 10% occur immediately before it, and in 3% occur randomly. Armed with this additional information, we can instruct the computer not only when to

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[2] *The preposition " za " can also have the English equivalents " behind ", " in ", " no translation " (za sčet = by), etc.*

[3] *The reverse of this supposition is not true, since these words can also occur with several other prepositions. There are, however, the words (for example, " blogodarit' " = to thank) the occurrence of which immediately predicts the occurrence of " za " and " for " as its only possible equivalent. All these words will formulate either a subclass or a separate class, depending on their frequency of occurrence.*

select a certain English equivalent of " za ", but also how to inspect the context to facilitate the decision. In this case, in order to determine whether a member of class W appears in the context, the computer would be instructed to inspect the second preceding word first, the immediately preceding word next, and so on.

It seems clear then, that the discovery of diagnostic environments would in principle enable us to reduce lexical ambiguity *by purely mechanical means.*

Although there has been considerable discussion concerning this problem, experimental studies to substantiate the various approaches have been extremely few and limited. The author is aware of only two published studies, that by A. Kaplan (1950) and that in a book by Booth, Brandwood and Cleave (1958). Kaplan concerned himself with the reduction of ambiguity in a single language, English, and consequently his findings are of no direct use to machine translation. The study in Booth, Brandwood and Cleave was based on 7,000 words of German text from a work on electron optics. Although they state that " for the text investigated it is possible to reduce multiple meaning to such an extent as to make it almost non-existent . . .", they make no mention of either the amount of context needed or the positioning of the diagnostic elements. The aim of the experiment now to be described was thus to discover, for the multiple meaning words contained in a larger sample of text than any previously used, what diagnostic classes exist for the various possible translations, and what regularities exist in the positioning of their elements.

THE EXPERIMENT

A necessary and obvious preliminary to all work on the multiple meaning problem is the assignment to each word of the input language as many English equivalents as may be needed. In the interests of efficiency it is desirable that the computer be burdened with the smallest possible number of selection rules, and for this reason our concern differs from that of the lexicographer. While he seeks the *greatest* number of discriminations *possible,* we seek the *smallest* number *necessary.*

Accordingly, the choice of alternative translations for any given word to be included in a mechanical dictionary will be subject to two restrictions. First, we shall want to eliminate all alternatives which cannot be expected to appear within the particular universe of discourse for which the translation programme is being developed. Secondly, confronted with a group of synonyms, we shall try to choose *one* word which covers the whole semantic range of the group without omitting any discriminations which the source word may require (although in some instances, it may be desirable to preserve multiple translations for stylistic reasons). Our present study involved a third limitation: our interest in the Russian words under consideration was confined to the limited range of meanings which each word happened to bear within one particular scientific text. For our purposes, therefore, we define a word as lexically ambiguous if it has more than one English translation within the given text.

The text used was a sample of 30,154 running words of Russian taken from a

current journal of physics.[4] This text was first of all " edited " in order (1) to obtain a more than ordinarily accurate translation, (2) to determine from this translation the correct English equivalent for each occurrence of a multiple meaning word throughout the text, and (3) to compile, on the basis of the results of (2), a minimal list of possible English equivalents for each multiple meaning word.

Following the editing, each word in the sample was key-punched on an IBM card. Then, with the help of a native speaker of Russian, a scientific dictionary, and an English translation[5] of the text, we examined the text and assigned to each word one or more English equivalents. The equivalents selected in this manner were then sent to the RAND Corporation where they were key-punched on our original IBM cards. The result was a deck in which each card contained a Russian word and one or more English equivalents.

At this point, to facilitate the editing, the text and translation were reproduced together on IBM paper as a vertical succession of words and punctuation marks (from the first word to the last, in the order of the text), so that each horizontal line contained a Russian word together with its possible English equivalent(s). This material was submitted to six interpreters, who were asked to read it carefully, correct the translation where necessary, and to identify the translation of each multiple meaning word required by considerations of broad context in each of its occurrences. Points of disagreement among the interpreters were re-examined, and in every case an equivalent agreeable to them all was selected.

On completion of the editing a new deck of IBM cards was prepared. Each contained (1) a Russian word, (2) its location in the text—page, line, and word number, (3) punctuation code, and (4) the translation required by the text. The experiment, which we are now ready to describe, was based on data taken from this new deck of IBM cards.

By simple manipulation of the deck, every occurrence of a multiple meaning word was collected.[4] Each occurrence, together with a contextual environment of one word before and one after, was listed alphabetically on duplicate IBM paper, and the minimal list of English equivalents for each ambiguous word was then inserted by hand. A copy of this material was given to each of two native speakers of Russian (each holding a degree in physics), with the following instructions:

" 1. The middle word of each Russian sequence has more than one English translation. You are to read each sequence in the manner described in instructions (2), (6), and (7) below, giving close attention to the meaning of the middle word. If, in your judgment, the middle word is completely unambiguous, you are to select for it one, and only one, of the English translations provided in the list, and no other. It is emphasized that you are not to judge a middle word unambiguous unless there is *no possibility* of its having more than one English translation in the given sequence.

[4] *See Appendix I.*
[5] *Published by the American Institute of Physics:* Soviet Physics - JETP, *Vol. 1, No. 1, pp. 1-196, July 1955.*

2. Cover the third word in each sequence and read the remaining sequence.
3. If the sequence is ambiguous, write " A " next to it.
4. If it is not ambiguous, write the numeral (1,2,3,..., etc.) of the English translation appropriate to the middle word of that sequence.
5. If the sequence constitutes an idiom, write " I " next to it.
6. Cover the first word in each sequence and repeat steps 3-5.
7. Look at the entire three-word sequence and repeat steps 3-5.
8. In all cases where the proper grammatical number of the English translation cannot be unambiguously decided by reference to the suffix of the middle Russian word, you are to choose the singular."

The reason for instruction (1) was to introduce the material to the informants and to prevent them from making an ill-considered choice. Instructions (3), (4), and (5) were necessary to separate the non-ambiguous from the ambiguous cases and idioms. Instructions (2), (6), and (7) were used to enable the author to discover precisely which element(s) in the non-ambiguous sequences determined the meaning of the middle word, and the positioning of these elements. Instruction (8) served to exclude a class of ambiguities[7] which for reasons of simplicity it seemed best to reserve for future experiments.

When the two informants had each completed a list in this way, they were asked to exchange their lists and check them against each other. All disparities discovered by this means were resolved by discussion to the satisfaction of both informants.

The final choices were key-punched on IBM cards and further checked for consistency by machine to insure that every occurrence of an identical sequence had received the same translation.

Finally, and again by computer, the material was statistically organized.

RESULTS

The results of the study are contained in Appendices I through III.

Appendix I lists the 255 different words to which more than one English translation was assigned within our text (any two words which differed from each other by at least one letter, e.g. " play " and " plays ", were considered different words). It should be noticed that multiple meaning words comprise less than 5% of the total number of different words, a proportion which seems much smaller than one would expect. However, the text contained a further 291 different words which obviously possessed more than one English translation, but which were excluded by our prior definition of " multiple meaning word " since each occurred only once within the text. If these words were considered multiple meaning words, as within a larger text they might have

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[7] *Number in Russian is determined by suffix. In some cases, however, the overlapping of suffixes may lead to ambiguities. Thus, svjaz (i) may be translated " coupling " or " connection " and the ambiguous suffix (i) leaves us secondarily in doubt about whether the chosen translation should take the plural or not.*

to be, then the number of multiple meaning words would be more than double (over 9% of all words). This suggests that the final solution of the multiple meaning problem for Russian physics will require the study of texts even larger than the one we are at present using (30,154 running words). The whole question of how much text in a given field must be studied in order to make reliable predictions about the behaviour of multiple meaning words in future texts, is at present shrouded in darkness, and the above result shows at any rate the order of magnitude of the task facing machine translation.

Appendix II is divided into two parts. Part A lists those multiple meaning words (Group A) whose meanings were identified in all occurrences. Part B lists those (Group B) whose meanings were not identified in any occurrences. These two groups of words represent the extremes of clarity and ambiguity (the third and largest group, 198 words, contained those words whose meanings were identified in some occurrences but not in others).

It is worth noticing that a considerable frequency gap exists between the two extremes. Thus in Group A there are two words which occur in the text more than 50 times, whereas in Group B there is no word which occurs in the text more than 5 times.

This at first suggested the hypothesis that the relative frequency with which the meaning of a given word was identified I/F (where I is the absolute frequency with which the meaning of a given word was identified) might be dependent on the frequency F of that word in the text. To test this, we plotted I/F versus F for our complete set of multiple meaning words, but the graph failed to show a simple relationship. However, the graphs of I/F versus F for (1) prepositions, (2) conjunctions, and (3) particles, personal/possessive pronouns, and demonstrative adjectives, did indicate a relationship between I/F and F, namely, that for the multiple meaning words belonging to these categories, the greater the frequency of occurrence of a word, the greater the relative number of times a given translation is appropriate.

This observation raised the question of how I/F varies from category to category. To determine this, we computed the average (in per cent) of I/F for the above categories, and then compared each of these with the average of I/F for the complete set of multiple meaning words. These averages are shown below:

Category	Average I/F in %
1. S	62·6
2. P	74·4
3. C	65·5
4. PA	80·6
5. S – P	61·7
6. S – P – C	61·6
7. S – P – C – PA	58·6

where S = the entire set of multiple meaning words, P = prepositions, C = conjunctions, PA = particles, personal/possessive pronouns, and demonstrative adjectives ; (−) = minus.

As can be seen, most of the above averages are higher than the average for the entire set of multiple meaning words (S), and this difference turned out to be statistically significant for all these categories except for (5) and (6). It seems reasonable to conclude from this that a word belonging to one of the high-average categories (P, C, or PA) will probably require less context to determine its translation than one belonging to a low-average category (e.g. S minus P, C, PA).

Appendix III presents some tentative descriptions of the diagnostic environments permitting the selection of correct translations.

It remains to state our results concerning (i) the general extent to which ambiguity was reduced, and (ii) the effect of positioning upon the relative efficiency of the elements of diagnostic environments.

Our informants were, as previously stated, asked to judge the clarity of the middle word of each three-word sequence in the three distinct contexts provided by (I) the preceding word, (II) the following word, and (III) the sequence as a whole. We were thus able to classify all sequences into the following five sequence-types:

SEQUENCE TYPE	CONTEXT I	CONTEXT II	CONTEXT III
1	clear	ambiguous	clear
2	ambiguous	clear	clear
3	clear	clear	clear
4	ambiguous	ambiguous	clear
5	ambiguous	ambiguous	ambiguous

It is clear that the frequency of sequences of type 5 must express the amount of ambiguity remaining in the text. Out of a total of 7,544 sequences, sequences of type 5 numbered 1,841 or 24·4 per cent.

The fact that so large a reduction of ambiguity can be achieved with a context of only one word before and one word after the word to be translated, suggests that a limited expansion of this context might reduce the problem to negligible proportions. Since, as will appear, the following word is approximately twice as effective as the preceding one in resolving ambiguity, it should be interesting to see what results can be achieved by simply adding a second following word. Work on these lines is already under way.

It is also of considerable interest that 1,069 (more than 50%) of the sequences of type 5 were accounted for by no more than sixteen different words, fourteen of which are prepositions and conjunctions. The words are as follows: a, v, veličiny, do, i, iz, ili, kak, na, ot, po, porjadka, pri, s, čerez, čto. (Note that this does not contradict our earlier remarks about the higher relative frequency of identification of prepositions and conjunctions.)

From the distribution of the remaining four sequence-types we were able to determine the extent to which the preceding or the following word, or both, influenced the reduction of ambiguity. These results are given in Table 1.

TABLE 1

Sequence Type	Number of Occurrences	Percentage* of all non-ambiguous sequences	Percentage* of all sequences
1	1,378	24·2	18·3
2	3,253	57·0	43·1
3	669	11·7	8·9
4	403	7·1	5·3
Total	5,703	100·0	75·6

* The last digits of the percentages are rounded off.

A combination of sequences of types 1 and 3 gives the sequences in which the ambiguity of the middle word is entirely resolved by the preceding word. Similarly, sequence-types 2 and 3 combine to give the sequences in which ambiguity is resolved entirely by the following word. Again, sequence-types 1, 2, and 3 combine to give the sequences in which ambiguity is resolved by either the preceding or the following word. The percentage frequencies of these combinations express the relative efficacy of the preceding and following words in resolving ambiguity, and are given in Table 2.

TABLE 2

Sequence Type	Number of Occurrences	Percentage of all non-ambiguous sequences	Percentage of all sequences
1 + 3	2,047	35·9	27·1
2 + 3	3,922	68·8	52·0
1 + 2 + 3	5,300	92·9	70·3

It seems reasonable to conclude from these results that the following word is much more effective in resolving lexical ambiguity than the preceding. It is also of interest that A. Kaplan (1950) obtained a similar result in his study of ambiguity and context in English.

On the basis of these results we propose to extend our work on multiple meaning in several directions. First, it should be interesting to see how much further it is possible to reduce lexical ambiguity by extending the context surrounding the ambiguous word. As has been stated, the most promising step in this direction seems to be the addition of a second following word: accordingly we shall go on to investigate first this context, then the context of two words before and two after, continuing in this way until ambiguity becomes negligible, or until diminishing returns make further extensions unprofitable.

Secondly, we intend to increase the amount of text to be studied in this way, a step which the present study has shown to be essential if we are to achieve anything like a complete resolution of ambiguity for Russian physics.

Finally, it seems certain that there will be some occasions on which the immediate context of a word will not yield enough information to determine its translation. One line of attack here would be an "extended context" study, the object of which would be to construct a set of probabilistic rules such that, given a word A, it will have a particular translation X if there exists anywhere in the same sentence or paragraph a word B. A pilot study has been designed to test the fruitfulness of this approach, and the results will be made available as soon as it has been completed.

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APPENDIX I

The text selected for analysis consisted of 30,154 running words of Russian from the *Zurnal Eksperimental'noj i Teoretičeskoj Fiziki* (Journal of Experimental and Theoretical Physics), Vol. 28, no. 1, pp. 1-128, 1955. This text contained 5,727 different words (play and plays, for example, are considered different words). The number of running words to which more than one English translation was assigned was 7,544 and the number of different words with more than one English translation was 255 (or less than 5% of the total number of different words).

The following is a transliterated, alphabetical list of the 255 different words with more than one English equivalent. The format used is: (1) the Russian word, (2) its frequency in parentheses, and (3) its English equivalents. Whenever two or more different words contained a common stem (or root), we have listed (1) the stem (or root), (2) the various suffixes having the common stem (or root) with the frequency of each in parentheses, and (3) the English translations assigned. When the assigned English translation has a suffix in parentheses, i.e. [great(er)], this indicates two separate English equivalents (1. great ; 2. greater).

1. a (97) = and, but
2-8. bol'š- ie(5), im(7), imi(2), ix(17), oj(11), uju(2) = great(er), large(r) ; e(20) = greater, larger, more
9-10. bud- et(71), ut(19) = will, will be
11-4. by- l(15), la(15), lo(27) = was, be ; li(13) = were, be
15-6. v(1062), vo(31) = in, into, at
17-21. veličin- a(45), e(11), oj(5), u(25), y(44) = value(s), magnitude(s)
22. velos' (2) = was conducted, was led
23. vidu (14) = form, mind
24-5. vnešn- ego (11), im(7) = external, outer
26-7. vnutrenn- ie(2), im(4) = inner, internal
28-30. vozmuščen- ie(9), iem(7), ija(22) = activation(s), disturbance(s), perturbation(s)
31-2. vrem- eni(36), ja(44) = time, period
33-7. vs- e(16), ego(7), ej(5), em(7), ja(3) = all, whole
38-41. vyvod- zero(10), a(2), e(4), y(3) = conclusion(s), derivation(s)
42. vypolnimosti (3) = workability, executability
43. vyše (15) = higher, above
44. granicy (4) = limit, boundary
45. dalee (7) = further, below, furthermore
46. dal'nešego (7) = further, future
47-8. dann- ye(5), yx(10) = given, data
49. dvjonoj (2) = double, binary
50. dlja (415) = for, in order to
51. do (59) = to, up to, before
52. drugoj (8) = other, another
53. ego (31) = his, him, it, its
54. ee (26) = it, its, of its
55. ešče (13) = still, more, moreover
56. že (113) = still, but, same
57. za (36) = in, for, per
58-9. zavisimost- i(27), ['] 27 = dependence, function
60. zadannyx (7) = given, yielded
61. zaključenija (2) = conclusion, inference
62-4. zametn- o(2), oj(2), yx(2) = noticeable, appreciable, apparent
65-70. značeni- e(20), i(3), j(19), ja(55), jam(8), jami(4) = value(s), significance, importance
71. i (801) = and, as well as
72. iz (138) = from, of
73. ili (55) = or, either
74. im (4) = them, by it
75. imenno (13) = namely, just, exactly
76-80. impul's zero(12), a(10), ov(11), om(5), y(8) = impulse(7), momentum (ta)

81. inym (2) = different, other
82. ix (32) = them, their
83. k (138) = to, by, for
84. každom (4) = each, every
85. kak (182) = as, how, both, like
86-7. kak- ie(3), oj(3) = what, which
88-92. kolebani- j(43), ja(11), jam(4), jami(11), jax(3) = oscillation(s), vibration(s)
93. kontur (3) = circuit, contour
94-6. korreljaci- i(9), ju(3), ja(10) = correlation, coupling
97. kotoryj (16) = which, who
98-9. lamp- zero(2), oj(2) = lamp(s), tube(s)
100. libo (4) = either, or
101. malo (16) = little, small
102. meždu (72) = between, among
103-5. men'š- e(16) = less, smaller ; ej(4), em(2) = lower, smaller
106. mnogo (9) = much, many
107-8. množitel- i(4), ['] (2) = multiplier(s), factor(s)
109. na (284) = on, at, per, for, by, in, into, onto
110. nam (11) = us, to us
111. namnogo (4) = much, by far
112. nastol'ko (5) = so, such a
113-4. naš- ej(10), ix(13) = our, of our
115-6. nekotor- ye(9), yx(13) = certain, some
117. nepodvižnyx (5) = static, fixed
118. neskol'ko (17) = several, somewhat
119. niže (12) = lower, below
120. nim (5) = it, them
121. o (47) = concerning, of
122. ob (5) = concerning, of, to
123-4. obrazovani- ju(2), ja(21) = production, formation
125-6. obrazu- etsja(2) = is produced, is formed ; jut(3) = produce, form
127-8. odinakov- y(6), yx(2) = same, equal
129. odnorodnosti (2) = uniformity, homogeneity
130. označaet (7) = designates, signifies
131. on (6) = he, it
132-4. opredelen- zero(4) = determined, defined ; naja(5), noj(3) = definite, determined, defined
135. opredelit' (9) = determine, define
136-41. opredelja- et(9) = determines, defines ; etsja(22) = is determined, is defined ; las'(2) = was determined, was defined ; t'(3) = determine, define ; t'sja(7) = be determined, be defined ; jutsja(8) = are determined, are defined
142-4. opredeljajušč- ej(2), ie(3), ix(2) = determining, defining

145-9. osnovn- ogo(6), oj(7), om(8), ym(2), yx(3) = main, fundamental, ground
150.   osobennosti (3) = peculiarity, particular
151.   osobyj (3) = separate, single
152.   ot (198) = from, on, of, with, due to, to
153.   otklonenija (4) = deviation, deflection
154.   otličajutsja (7) = differed, are distinguished
155.   otmečennye (2) = marked, noted
156-7. otnošeni- e(12), ja(8) = ratio, relation
158-60. ocenk- a(10), i(4), u(2) = evaluation, estimation
161.   padaet (6) = falls, decreases
162.   pered (3) = before, front
163.   perejti (2) = pass over, proceed
164.   plavno (2) = even, smooth
165.   ploskoj (2) = flat, plane
166.   po (196) = according to, along, by, in, on
167.   pod (33) = under, by
168.   poka (3) = until, as yet
169.   polnogo (6) = entire, full, total
170.   porjadka (37) = order, factor
171.   porjadok (13) = order, factor
172-3. posledn- ee(9), ie(3) = last, latter
174.   postavlen (3) = set, formulated, posed
175.   postroen (3) = build, formulated
176.   potok (2) = stream, flow
177.   predstavit' (8) = present, represent
178-9. predstavlen- ie(7), ija(10) = representation, idea
180-1. predstavlja- et(13), jut(5) = seems, represent(s), present(s)
182.   pri (410) = at, in, for, within, during, with, under
183.   približenija (11) = approximation, approach
184-9. priveden- a(2), nogo(2), noe(2), nye(2), nyx(2), y(5) = quoted, showed, reduced
190.   privodjat (5) = lead, quote
191.   privodjatsja (4) = are brought, are shown, are reduced
192.   primem (5) = will take, will assume
193.   prinimaja (5) = taking, assuming
194-6. prinja- v(2) = taking, assuming; li(2) = took, assumed; t'(6) = take, assume
197.   provodimosti (20) = conduction, valence
198-9. proizved- eno(2) = made, conducted; ja(2) = making, conducting
200-2. proizvodi- lis'(5), los'(3) = (was/were) produced, (was/were) made; tsja(6) = is produced, is made
203.   proizvodja (2) = producing, making
204.   projavlenie (2) = manifestation, development
205.   putem (12) = way, by means of

206-7. razloženi- e(9), ja(6) = expansion, reduction
208-9. rassejani- i(3), ja(21) = diffusion, scattering
210-11. s (350), so (18) = with, from, on, to
212. svoej (5) = its, his
213-7. svjazan- a(3), nogo (4), noj(4), nye(3), nyx(8) = connected, bound, related
218-9. svjaz- i(19), ['] (10) = connection, coupling
220. sdelat' (9) = make, do
221-2. seb- e(2), ja(2) = itself, themselves
223-5. slab- o(7), oe(2), yx(2) = slightly, little, weak
226. sleduet (32) = follows, one should
227. soboj (18) = itself, themselves
228. sootvetstvenno (16) = corresponds to, accordingly, respectively
229-30. sostav- zero(3), a(12) = compound, composition
231-4. sostojani- e(6), i(33), j(6), ja(12) = condition(s), state(s)
235-6. stepen- i(8), jam(6) = degree(s), power(s)
237-8. storon- u(3), y(4) = side, direction
239-40. ščita- em(3), t'(10) = consider, assume
241. tak (85) = so, thus, the same way
242-4. tverd- ogo(4), om(2), yx(9) = solid, hard
245. tem (28) = those, the, that, by the fact, circumstance
246-9. to- zero(107) = the, then, the fact ; go(23), m(30), mu(6) = that, the fact
250. čem (39) = than, by which, the
251. čerez (47) = across, through, by
252. čto (331) = that, which
253. čtoby (15) = in order to, that
254-5. ét- im(3) = this, by this fact ; o(64) = this, it

Appendix II

Appendix II has been divided into two parts. Part A contains those multiple meaning words whose meanings were completely identified by the native informants in every occurrence of each word. Part B contains those multiple meaning words for which the informants were unable to select even *once* the proper meaning (i.e. every sequence containing such words belongs to sequence-type 5).

The format used for Part A is as follows: (1) the Russian word in transliteration, (2) its English translations, and (3) the frequency of each sequence-type (i.e. the number of times each meaning was determined from the preceding word, or the following word, or both). The format used for Part B is identical with the one used for Appendix I.

PART A

Russian Word	Translation	Sequence Type				Total
		1	2	3	4	
1. bylo	was		20		4	24
	be		1			1
	idiom				2	2
2. vidu	form			7		7
	mind	1		6		7
3. vnutrennie	inner		1			1
	internal		1			1
4. vsego	all	6				6
	whole			1		1
5. vsej	all		1			1
	whole			4		4
6. vsem	all			6		6
	whole			1		1
7. vsja	all		1			1
	whole		2			2
8. vyvoda	conclusion		1			1
	derivation		1			1
9. dannyx	given		3			3
	data	3		4		7
10. zametno	noticeable		1			1
	appreciable		1			1
11. zametnoj	noticeable		1			1
	appreciable		1			1
12. zametnyx	noticeable		1			1
	appreciable		1			1

	Russian Word	Translation		Sequence Type			
			1	*2*	*3*	*4*	*Total*
13.	značenie	value	6	3	5		14
		significance	2		1		3
		importance	3				3
14.	ix	them		3		2	5
		their		12	15		27
15.	kakie	what		2			2
		which		1			1
16.	kakoj	what		1			1
		which		2			2
17.	mnogo	much		6	2		8
		many		1			1
18.	namnogo	much		2			2
		by far		2			2
19.	nastol'ko	so		2			2
		such a	1		2		3
20.	našix	our	1		10		11
		of our	2				2
21.	nekotorye	certain		6	2		8
		some		1			1
22.	nekotoryx	certain		12			12
		some		1			1
23.	nepodvižnyx	static		1			1
		fixed		4			4
24.	neskol'ko	several		6			6
		somewhat		11			11
25.	ob	concerning	3				3
		of	1				1
		to	1				1

	Russian Word	Translation	Sequence Type				
			1	2	3	4	Total
26.	opredelennoj	definite			1		1
		determined	2				2
27.	osobennosti	peculiarity	2				2
		particular	1				1
28.	perejti	pass over	1				1
		proceed	1				1
29.	potok	stream		1			1
		flow		1			1
30.	predstavit'	present		1			1
		represent	7				7
31.	predstavlenie	representation	1	3	2		6
		idea		1			1
32.	predstavljajut	represent				1	1
		present		1			1
		idiom			3		3
33.	privedennoe	quoted		1			1
		reduced		1			1
34.	privedennyx	quoted				1	1
		showed		1			1
35.	privedeny	quoted				3	3
		showed		1		1	2
36.	prinjali	took		1			1
		assumed		1			1
37.	putem	way	3				3
		by means of	8		1		9
38.	svjazannyx	bound		4	1		5
		related	3				3

	Russian Word	Translation	Sequence Type				
			1	2	3	4	Total
39.	slaboe	weak		1			1
		slightly		1			1
40.	sootvetstvenno	corresponds to	2				2
		accordingly		1	5		6
		respectively	2	3	3		8
41.	storonu	side		1			1
		direction				2	2
42.	tak	so		14			14
		thus		11			11
		the same way		6			6
		idiom		54			54
43.	tverdyx	solid		8			8
		hard		1			1
44.	to	the		4			4
		then		87		1	88
		the fact				1	1
		idiom		7		7	14
45.	tomu	that			1		1
		the fact				1	1
		idiom		3		1	4

Part B

1. dvojnoj (2) = double, binary
2. inym (2) = different, other
3. kontur (3) = circuit, contour
4. men'šem (2) = lower, smaller
5. mnozitel' (2) = multiplier, factor
6-7. opredeljajušč- ej(2), ix(2) = determining, defining
8-9. priveden- a(2), nye(2) = quoted, showed, reduced
10. proizvodja (2) = producing, making
11. svjazannoj (4) = connected, bound, related
12. sebja (2) = itself, themselves

Appendix III

This appendix presents some of the diagnostic environments which were found to permit the selection of correct translations for particular multiple meaning words. In selecting this material two restrictions were observed: (1) Everything relating to prepositions was excluded, since the whole problem of the machine translation of prepositions from scientific Russian into English is being dealt with in a current study by a member of our group. (2) No word was included unless at least one of its meanings was correctly identified in ten or more occurrences. The choice of this particular list was in part arbitrary. For reasons of space it was necessary to set up some principle of exclusion, and in deciding on a frequency limit of ten occurrences of a given meaning we hoped to ensure that the words included would offer a reasonable basis for generalization.

Of the 243 multiple meaning words remaining after subtracting the 12 words which remained completely ambiguous in the experimental context, the above two restrictions eliminated 207, leaving a list of 36 words only. The format used in listing these words is as follows: (1) the Russian word, (2) a description or statement of the diagnostic environments determining its translation, and (3) the English translation determined by each environment, with its frequency of occurrence in parentheses.

Where the note " AMBIGUOUS " occurs in the third column, this means that in one or more cases the informant was unable to select any of the possible translations with which he was supplied as the correct one. Thus for " značenij " the possible translations as given in Appendix I are (a) values, (b) magnitudes. In this appendix it will be found that the translations listed are (a) values (15) and (b) AMBIGUOUS (4). Thus, there were 15 occurrences in which it was plain that " značenij " meant " values ", and four in which it remained uncertain whether it meant " values " or " magnitudes ". " Following " occurring in a description of a diagnostic environment should be taken to mean " immediately following ", and " preceding ", " immediately preceding ".

Russian Word	Diagnostic Environment	Translation
1. budet	Followed by a non-reflexive infinitive. Followed by a reflexive infinitive; or not followed by a comma, period, "to", an adverb, or a preposition. Elsewhere.	will (20) will be (28) AMBIGUOUS (23)
2. bylo	Followed by a past passive participle or a verb. "dolžno bylo by" = idiom. "možno bylo by" = idiom. Elsewhere.	was (24) should have been (1) could have been (1) be (1)
3. veličina	Followed by "intervala, otnošenija", or a mathematical expression. Followed by "perioda, toka, énergii", or "éffekta". Elsewhere.	value (26) magnitude (6) AMBIGUOUS (13)
4. veličiny	Followed by "koéfficienta, poglošćenija" or a mathematical expression. Followed by "énergii". Elsewhere.	values (16) magnitudes (1) AMBIGUOUS (27)
5. vozmuščenija	Preceded by "zatuxaniju, istočnika, povedenie" or any form of "énergija". Elsewhere.	disturbance (6) AMBIGUOUS (16)
6. vremeni	Preceded by "edinicy", any form of "moment", "nastojaščego, nekotorogo, po, postajannaja, prodolžitel'nogo, tečeniem"; or preceded by "ot" *and* followed by "raspredelenija"; or preceded by a mathematical expression *and* followed by a period. Followed by "spin-rešetočnoj"; or preceded by "ot, polnomu" *and* followed by "nagrevanija" or a mathematical expression. Elsewhere.	time (24) period (3) AMBIGUOUS (9)

Russian Word	Diagnostic Environment	Translation
7. vse	Not followed by any form of "impul's". "vse že" = idiom. Elsewhere.	all (11) still (3) AMBIGUOUS (2)
8. ego	Preceded by "peregrevom, vyše, dlja, i, pri" or "plotnosti"; or followed by "dekrementa, maksimal'naja, matrica, osi, os', poverxnosti, radiusa, svojstva, temperaturu, udel'noe, universal'nost, forma". Followed by "vtorično" or "ėkranirovat'"; or preceded by "is-pol'zovanii" and followed by "kak". Elsewhere.	its (19) it (3) AMBIGUOUS (9)
9. ee	Preceded by a singular verb *and* followed by "v" or "po". Followed by "dipol'nogo". Not preceded by a verb or "i". Elsewhere.	it (2) of its (1) its (18) AMBIGUOUS (5)
10. že	Preceded by any form of "takoj", "ėtot", or "tot" (except "tomu"); or the word "tak". Preceded by "esli", a noun, a long form adjective, except "ostal'nom". Preceded by "vse" *and* followed by a comma or "izmenenie". "čto že kasaetsja" = idiom. "srazu že" = idiom. Elsewhere.	same (80) but (22) still (2) as for (2) immediately (1) AMBIGUOUS (6)
11. zavisimosti	Preceded by "postroenija" or followed by a mathematical expression, "vida" or "vyražaemoj". Followed by "ot". Elsewhere.	function (10) dependence (9) AMBIGUOUS (8)

12. značenie

Preceded by "osoboe, principial'noe" or "sobstvennoe". — significance (3)
Preceded by "bol'šoe" or "suščestvennoe". — importance (3)
Elsewhere. — value (14)

13. značenij

Followed by a mathematical expression or "matricy, temperatury, funk'cij, peremennyx". — values (15)
Elsewhere. — AMBIGUOUS (4)

14. značenija

Preceded by "vyčislennye, men'šie, veličin" or "polučajutsja"; or followed by a mathematical expression or "vremen, koéfficienta, raznosti, veličiny, dliny, matricy, plotnosti, polja, skorostej, soprotivlenija, énergii, éntropii". — value (49)
Elsewhere. — AMBIGUOUS (6)

15. i

Preceded by a punctuation mark, a mathematical expression, or a reference symbol; or not preceded by "kak, tak, takže, xotja" or "čem"; or not followed by a preposition, "drugie, veščestvennye, pozvoljaet, posvjaščeno; or not preceded by "my" or "nami" and not followed by "pol'zovalis" or "bylo". — and (684)

Preceded by "vključaja, vozmožen, no, odnako, pričem, to" or "čto"; or preceded by "vypolnjaetsja, ispol'zovan, obrazom", any form of: (1) "nabljudat', (2) primenen", or (3) "spravedlivy" and followed by "dlja" or "v". — also (40)

"kak i" = idiom.
"(kak...) tak i" = idiom. — as (24)
"takže i" = idiom. — as...so (13)
"xotja i" = idiom. — also (6)
"čem i" = idiom. — although (1)
"i posvjaščeno" = idiom. — which (1)
"my i pol'zovalis" = idiom. — is dedicated (1)
"nami i bylo" = idiom. — we used (1)
Elsewhere. — we (1)

AMBIGUOUS (29)

RUSSIAN WORD	DIAGNOSTIC ENVIRONMENT	TRANSLATION
16. ili	Preceded or followed by parentheses ; or preceded by a form in the same number and case as the following form ; or followed by " daže ".	or (25)
	Preceded by " predstavleno ".	either (1)
	Elsewhere.	AMBIGUOUS (29)
17. ix	Followed by " možno ", comma, or rtut'ju ".	them (5)
	Elsewhere.	their (27)
18. kak	Preceded by " interpretivov ", any form of " rassmatrivat', trak- tovat' " ; or followed by a short form adjective, auxilliary verb, personal pronoun, reflexive verb (other than " izmenjaetsja "), " naličie, obyčno, takovoe, ugodno, uže," *comma and " naprimer* ", or " neodnokratno ".	as (87)
	Followed by " izmenjaetsja ".	how (1)
	Preceded by " nabljuden, porjadok, proisxodit' " or " spravedlivo ", and followed by " prjamymi, dlja, vdol' " or " sovetskix ".	both (5)
	" tak kak " = idiom.	since (40)
	" togda kak " = idiom.	while (10)
	Elsewhere.	AMBIGUOUS (39)
19. kolebanij	Preceded by " zvukovyx, uprugix " ; or followed by " dipol'noj, koaksial'nogo " or " plazmy ".	vibrations (18)
	Preceded by any form of " amplituda ".	oscillations (2)
	Elsewhere.	AMBIGUOUS (23)
20. kotoryj	Preceded by a comma and a singular, masculine noun (other than " avtor " or a noun beginning with a capital letter).	which (11)
	Followed by " našel " or " obobščil ".	who (2)
	Elsewhere.	AMBIGUOUS (3)

21.	našix	Preceded by " v, iz " or " na ". Elsewhere.	our (11) of our (2)
22.	nekotoryx	Followed by " iz ". Elsewhere.	some (1) certain (12)
23.	neskol'ko	Followed by a noun or " načal'nyx ". Elsewhere.	several (6) somewhat (11)
24.	obrazovanija	Preceded by any form of " sečenie ". Elsewhere.	formation (12) AMBIGUOUS (9)
25.	porjadka	Preceded by any form of " veličina ", by an ordinal numeral, and by " koéfficient " or " intensivnostej ". Elsewhere.	order (11) AMBIGUOUS (26)
26.	provodimosti	Preceded by any form of " élektron ". Preceded by " poverxnostnoj "; or followed by " metala, obrazcov " or " olova ". Elsewhere.	valence (10) conduction (6) AMBIGUOUS (4)
27.	rassejanija	Preceded by any form of " amplituda " or " kombinacionnogo "; or followed by " naletajuščej, nejtronov, protonov, fononov " or " élektronov ". Elsewhere.	scattering (15) AMBIGUOUS (6)
28.	sleduet	Followed by an infinitive or a *comma, and not " čto "*. Followed by a *comma and " čto "*; or preceded by " éto, kotoroe " *and* followed by " iz ". Elsewhere.	one should (21) follows (9) AMBIGUOUS (2)

Russian Word	Diagnostic Environment	Translation
29. soboj	Preceded by " predstavljaet ". Preceded by " meždu, predstavljali ", or " predstavljajut ". Elsewhere.	itself (6) themselves (11) AMBIGUOUS (1)
30. sostojanii	Preceded by " židkom, konečnom, sverxprovodjašče, svobodnom, svaz-annom, stacionarnom, tverdom ", or " uporjadočennom ". Elsewhere.	state (17) AMBIGUOUS (16)
31. tak	Followed by a comma *and* " čto " or " čtoby ". Followed by a comma *and* not " čto, čtoby " or " že ". " (kak...) tak i " = idiom. " tak kak " = idiom. Elsewhere.	so (14) thus (11) as...so (14) since (40) the same way (6)
32. to	Followed by " obstojatel'stvo ". Preceded by " na " *and* followed by *comma and* " *čto* ". " to že " = idiom. " v to vremja (kak) " = idiom. Elsewhere.	the (4) the fact (1) the same (7) while (7) then (88)
33. tom	Followed by " ili, otnošenii " or " slučae ". Preceded by " o " *and* followed by a *comma and* " *čto* ". " tom že " = idiom. " (v) tom čisle " = idiom. Elsewhere.	that (13) the fact (4) the same (1) including (1) AMBIGUOUS (11)
34. čem	Not followed by a comparative adjective or " i ". Followed by a comparative adjective. " prežde čem " = idiom. Elsewhere.	than (30) the (5) before (3) AMBIGUOUS (1)

35. čto

Preceded by a comma *and* any form of a verb (other than "videt'" and "vytekaet"), or "dopuščenie, predpoloženie, zaljučenie, takoj, to, jasno"; or "obstojatel'stvo, očevidno, tak, izvestno, interesno, t.e., xarakterno" or "častnosti"; or followed by neither "možno", a singular verb, nor "spravidlovo". that (265)

Followed by "spravidlovo" or a singular verb other than "obespe-čivaetsja, možno". which (26)

"čto že (kasaetsja)" = idiom. as for (2)

"potomu, čto" = idiom. because (1)

"ottogo, čto" = idiom. because (1)

Elsewhere. AMBIGUOUS (36)

36. éto

Not preceded by "kak" or "i" *and* followed by a singular neuter noun, a singular verb, an infinitive, a past passive participle, a comma, "možno" or "samo". this (55)

Preceded by "kak" *and* followed by a singular verb, an infinitive, or past passive participle. it (8)

Elsewhere. AMBIGUOUS (1)

QUANTITATIVE STUDY OF THE SPEECH OF AUSTRALIAN CHILDREN

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The syntax of the speech of Australian pre-school children is studied quantitatively. Two syntactic systems for this language are designed and samples of their outputs are given.

QUANTITATIVE SURVEY OF SYNTAX IN A SAMPLE OF THE SPEECH OF AUSTRALIAN PRE-SCHOOL CHILDREN

1.1 *Description of the sample.*

The sample was drawn from the transcript of children's utterances recorded for the Australian Council for Educational Research's vocabulary project described in A.C.E.R. Information Bulletin No. 23, A Vocabulary of Australian Pre-school Children, July 1951 and A.C.E.R. Bulletin No. 30, The Functional Classification of Child Speech, June 1953.

The following description of the way in which the utterances were collected is taken from Bulletin No. 30 Part II, p. 1 - 2:

" On November 20th to 24th and November 27th to December 1st inclusive, 1950, a group of twenty-four children aged 4 years 11 months to 5 years 8 months was assembled by the A.C.E.R. at the Lady Gowrie Pre-School Centre, North Carlton, Melbourne, Victoria. The group was selected by the staff of the A.C.E.R. as representative of all those children in the area who were to start, in 1951, at the Lee Street State Primary School.

The purpose was to make records of their speech in a variety of situations so that a speech vocabulary representative of such children might be drawn up. The speech was recorded by stenographers, who, stationed at various places in the Centre, recorded what was said by children who came into their allotted area. The children wore numbered jackets to make it easy to identify them, and the child's number was placed against the record of its speech. A typical record ran:

Child's No.

9.	I'm running down, too.
3.	Ooh, gee !
6.	I can't get down.
19.	We're going to do something.
9.	This is going to be right down the boat.
22.	Go on, go down.
19.	You go down first.
22.	This time I'll put my skirt under.

The area from which the children come is a relatively poor one. The majority of the people living in it are semi-skilled and unskilled workers doing routine jobs. A high proportion of mothers (for Australia) go out working. The houses they live in are usually part of a terrace, built side by side with small backyards and smaller front ' patches ' which may or may not support a flower garden. The rooms are usually poorly lit, the play and living space is small, and there is little opportunity to play indoors or outdoors within the house block. Parental ambitions for the children tend to be a little higher than the present parental status: the wife of an unskilled worker will want her boy to be a skilled worker, for example. Parental interest in the children is good, but the children are not, in general, subject to the same pressures for high speech skills, that would operate in areas of higher social standing.

There were twelve boys and twelve girls in the group: of each sex four came from those already regularly attending the centre, four from other kindergartens and creches in the area, and four from homes which had been either unable or unwilling in the past to arrange for the children to go to kindergarten." [1]

1.2 *Use of the sample to construct the quantitative survey.*

(a) All contractions used by the recorders were expanded. Example: " I'm going " in transcript is treated as " I am going."

(b) The quantity of non-standard speech forms was found to be very small. Non-standard forms were standardised. Example: " I done it " was standardised to " I did it." Some details of non-standard forms are given in Table 19.

(c) The dialogue form of the transcript readily provided the unit: *utterance.* The boundaries of an utterance are marked by change of speaker. The transcript contained approximately 12,700 utterances consisting of approximately 99,000 running words.

(d) The *sentence* was taken as the largest unit of the syntax. Utterances consisting of more than one sentence were divided into their constituent sentences. A formal

definition of sentence will emerge at the end of our work as a class of sequences derivable from a syntactic system.

(e) There were very few sentences of more than 10 words in length in the sample. These were excluded from the quantitative survey. However sentences of length greater than 10 words will be generated by the syntactic systems based on the quantitative survey so these sentences will not be neglected.

(f) A large number of quantitative surveys of the principal syntactic features of the sample were made by hand clerical methods.[2] A selection of those which are most useful in designing various syntactic systems for the language studied is presented. It must be emphasised that these surveys were made to get information for design, especially information on such questions as how to design the phrase and sentence structure systems, where to introduce variables and what values to allot to them, and, for systems using transition probabilities inside the syntactic system, how to assign the probabilities. They are not put forward as a complete statistical study of every word in the transcript but as the best information which could be obtained from the transcript on the features under survey. For statistical syntax the work should be regarded as a pilot survey. For more detailed work an electronic data processing machine would be indispensable and the surveys presented here indicate how it could be programmed. It is stressed that for the approach adopted here quantitative information of the kind presented in the surveys is not valued for its own sake but *only in so far as it improves the quality of the performance of the linguistic system within which it is incorporated.*

1.3 *The quantitative survey.*

The quantitative survey is presented in Tables 1 to 19.

Table 1 lists the syntactic symbols used in the quantitative survey.

Table 2 shows the principal verb constructions. Rows 1-70 of this table give the number of times the verb at the left of the row is followed by each of the structures shown at the top of the columns. The values of N, D and A are fully specified by later tables. Starred items are those where the corresponding unstarred item underlies the construction. One example of each follows. (All examples are sequences actually occurring in the sample.)

.	I am *coming*
D	*come* back again
D*	where does that *go* ?
N	*do* some
N*	what I *do*
N D	*put* it back
N* D	what I am *getting* out

N D*	when I am *doing* this
N N	*give* me a book
N N*	what I will *give* you
N N D	do they *give* you food when it is dinner time ?
A	*be* careful
A D	it *is* good today
N A	you *make* me sick
N A D	Alan has *got* his number dirty on the front
to v-1	I am *going* to help him
v-3	*stop* doing that
N v-1	I will *make* you eat your head
N to v-1	*help* me to pull this bucket of water
N v-3	I can *see* someone eating their dinner

Row 71 gives the number of times the remaining verbs (i.e. those lower in frequency than those listed in Rows 1-70) are followed by each of the structures shown at the top of the columns.

Table 3 lists for the verbs in Rows 1 to 70 of Table 2 the number of times, if any, they are followed by structures other than those shown in Table 2, and also the special statement constructions of *be, come* and *go* which are not of the form: N V. Tables 2 and 3 together completely specify the constructions occurring after the 70 most frequently occurring verbs. A striking feature of Tables 2 and 3 is the negligible occurrence of passive constructions. In view of the relevance of this result to the view that the passive constructions should be handled as transformations, the complete list of *be* v-5 constructions is given in Appendix I. A study of the occurring forms will show that the passive is hardly required at all in this language if selected v-5 forms are added to the values of a in A.

Table 4, Parts 1 and 2, gives details of the finite verb phrases occurring in statements, questions and commands. Rows 1-70 of this table give the number of times the verb at the left of the row occurs with each of the finite verb structures shown at the top of the columns. (*Be* is under-differentiated in this table: the selection of the required forms will be dealt with later.) Row 71 gives the same information for all other verbs.

Table 5 gives the values of the variable r in Table 4 and their probabilities.

Table 6 gives the values of the variable d in Table 4 and their probabilities.

Table 7 gives the probability of various prefixes, including zero, to v-1 in commands.

A remarkable positional patterning is displayed in the adverbial phrases. Very nearly all of them can be generated by selecting in order from the five classes of adverbials set out in Table 9 under D1, D2, D3, D4, D5, passing over the classes from which no item is required. (An elaboration of this layout would include the very small remainder.)

Table 8 gives the probabilities of the possible combinations of D1 - 5 as values of D. The first row gives the probability of an adverbial other than those derived from

D1 - 5, the second row gives the probability of an adverbial consisting of a D5 only, and so on. Blank rows are omitted.

Table 9 gives the items occuring in D1 - 5 and their quantities.

Table 10 gives the values of A (adjective phrase) and their quantities.

Table 11, Parts 1 and 2, gives an overall quantitative survey of the values of N (noun phrase). The four columns following each entry give in order its occurrences as (i) a value of N in n(p N) written N_n, (ii) a value of N before V written N_1, (iii) a value of N after V written N_2 and (iv) a value of N in p N written N_p.

Table 12 gives the frequently occurring values of n in N. The first number of the pair given after each noun is the number of times it occurs in the singular form, the second the number of times it occurs in the plural.

Table 13 gives the distribution of some high frequency noun head words with some quantifiers. The first number of the number pairs is the number of times it occurs in the singular form, the second is the number of times it occurs in the plural.

Table 14 gives the occurrences of frequently occurring values of a in A and N.

Table 15 gives the values of p in Table 11 and their probabilities.

Table 16 gives the values of pr-3 in Table 11 and their probabilities.

Table 17 gives the quantities of different types of questions.

Table 18 gives details of the interrogative endings used to convert statements to questions.

Table 19 gives the principal non-standard forms which were standardised and their quantities.

2. SYNTACTIC SYSTEMS

2.1 *Introduction.*

The generation of a sentence can be regarded as the selection of a particular sequence of morphemes from the set of all possible sequences of the morphemes at the command of the speaker. Consider for example the selection of a sentence to describe a visual presentation. The selection is made subject to (a) *syntactic constraints* which eliminate many possible sequences as ungrammatical and (b) *meaning constraints* which eliminate many of the survivors.

Of course a satisfactory linguistic performance does not always require all possibilities eliminated except one. In these cases the final selection may be random as far as the linguistic system is concerned. In this paper we concentrate on syntactic constraints. Meaning constraints will be dealt with in a later paper.

The sentence *John took my cars* illustrates the application of the following syntactic constraints, not necessarily in the order stated. (The syntactic symbols used are fully listed in Table 1.)

(1) selection of standard statement type sentence of the form: N_1 V ....

(2) selection of singular proper name, ñ-1, as a value of N_1

(3) selection of *John* as value of proper name

(4) selection of *take* to fill the leading variable in V

(5) selection of preterit form of *take* as value of V

(6) selection of the construction " *take* N₂ " to complete the sentence

(7) selection of a possessive pronoun followed by a plural noun as value of N₂

(8) selection of *my* as the value of the possessive pronoun and *car* as the value of the noun

In the notation used in this section this is represented compactly by

```
|————S————————|
|–N₁–|—V—|—N₂——|
ñ-1   v-4  pr-3   n-2
John  took  my    cars
```
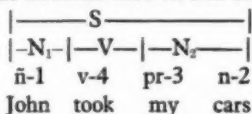
While the extensive introduction of variables in the syntactic system is necessary to predict the class of grammatical sequences from a small sample of them, not all sentences need be generated in the manner illustrated. Considerable use may be made of a memory from which frequently used formulas and semi-formulas such as

There's a... , Give me a... , I want a...

can be extracted. The role of the memory can be increased until the function of the linguistic system is restricted to patching the best matching item obtainable from the memory to fit a new requirement. No attempt is made to determine the role of memory in the child case as it would involve the examination of the linguistic through-put of a number of individuals to determine the nature of the transformations required to obtain each output sequence from the previous throughput. Whatever role is allotted to memory, the main function of the syntactic system is to offer possible ways of completing a phrase or a sentence structure subject to other constraints. This should be taken into account in evaluating the performance of such a system when it is operated without meaning constraints.

The following sub-sections briefly outline two syntactic systems which may be based on the data of the quantitative survey.

2.2 *A two valued syntactic system.*

For the purposes of this exposition we shall confine our detailed attention to state-ment type sentences. It will be seen from the quantitative survey that an adequate statement syntax can readily be extended to questions (by changes of phrase order, insertion of interrogative words or endings), and to commands (by taking the verb and the structure after it).

Statement type sentences can be divided into a few quite high frequency but very restricted formulas (e.g. *this/that/here/there* with *be, here/there* with *come* and *go*) and the one dominant type, N V, i.e. the sentences formed by choosing a noun phrase subject, a finite verb phrase and continuing the sentence according to the constraints of the verb construction (Tables 2 & 3), filling the variables from the different phrase systems.

We shall now examine the output of a system of two valued formation rule syntax based on the tables of the quantitative survey. In this system the tables will simply be used to indicate sequences that occurred without making any use of the information

they give about the relative frequency of the various items. Such a system can be realized by an automaton which stores the tables and selects from them according to the following instructions.

Programme for two-valued syntactic system:

Fill the word positions of the sentences from left to right as follows:

(1) Select a sequence from the N_1 table. Fill any variables in it from the appropriate tables.

(2) Select a value of v and a verb construction from Table 2. Fill the phrase variables from the appropriate tables.

(3) Select a value of V from Table 4, taking account of verb concord. Fill r and d from Tables 5 and 6 if they occur.

(4) Stop when . is reached. This gives a complete sentence. (Note that stop is to be understood after each of the constructions in Tables 2 and 3.)

(5) If a second v is reached in carrying out these instructions select a value of v from the verb construction table, fill its phrase variables until stop is reached and then continue with the next instruction, if any; if there are no further instructions, stop. This gives a complete sentence.

(6) If N V is reached return to (1), go through the instructions till stop is reached; and then continue with the next instruction if any; if there are no further instructions, stop.

(7) Procedure for D is as follows. Select a line from the D combination table. Select from the chosen D sub-systems in ascending order. Fill any phrase variables and word class variables.

The following sentences were obtained from the tables by carrying out these instructions using random numbers to make a choice whenever alternatives offered, all alternatives equi-probable.

(1) All the others have nearly made all the deep cupboards nice. (2) That must bring the prettiest dough from my two gaols. (3) Not much had better move home on Mary till teatime. (4) Its long pants may tell everything something lovely. (5) Mary can even paint any more. (6) One more slide may easily hold the front no pigs took everywhere either. (7) All beautiful records might jump. (8) The others see up him anyhow. (9) Too many pipes may hardly jump somewhere where two more are all sitting across quickly then either. (10) Mine has stopped watching. (11) Some more should only hurry. (12) Only a proper glass should leave the last pretty spider stand nothing for ages anyway. (13) No more buckets are just giving such a wheel anyone. (14) Your wet flower should hang in time. (15) A few more will be going hot and wet. (16) The pram minding all mine finds all a leader. (17) All the horse must just hurry like their other eye hurt five minutes. (18) One more board does not care for about two days. (19) Another flower started many seats. (20) Only the photos are not even getting this garage here one piece. (21) The other bridge still helps past along the fish by it. (22) This new caterpillar is only having to say. (23) We both could live inside heavy caps same time as a lot more. (24) Too much let that outside come still ready.

Various possible improvements in the system will immediately suggest themselves to the reader. We could do with more constraint on subordinate clauses, and a set of constraints from particular values of v to particular values of D_1 and D_2. On the other hand we might like to be rather more daring in other respects. For example we might make a sequence occurring in any one N sub-system available in all the other N sub-systems except in a few special cases like *I/me,* etc., and we could let all verbs assume any value of finite verb phrase from Table 4. The criterion for all such proposed adjustments is that the syntactic system must satisfy the conditions of good positive and negative fit (Harwood, 1955). If the permitted set of sequences is constrained severely towards the sample on which it is based it will prevent the formation of other sequences which are required and are correct in the language concerned. If it is not sufficiently constrained it will permit ungrammatical sequences.

2.3 *A probabilistic system.*

We shall now consider a system of formation rule syntax which takes account of the frequency with which various sequences occur in the sample on which it is based.

The following sentences were generated from the tables by the programme given in the preceding section modified as follows. All verbs were allowed to enter all the statement type finite verb phrase structures given in Table 4. Wherever alternatives offered they were allotted probabilities based on the frequencies given in the quantitative survey and a choice made by random numbers:

(1) That got John there over us. (2) I get my boy. (3) John minds me up in those ones. (4) It is having us. (5) I take a tree over. (6) You are that. (7) You are making you. (8) I am not doing that. (9) I have me. (10) It is now. (11) I do not give one more sleep of my tyre us. (12) I am getting making us. (13) He gets me. (14) This one gets one to the bubbles. (15) I am not out. (16) You give a garage mine now. (17) I am my paper. (18) I stop. (19) Some more got your sand. (20) One is not knowing it. (21) You go and want to know Mary has done the caterpillar we can be pretty down. (22) My garage is falling here. (23) I am not one. (24) An orange was a record. (25) You will think you see. (26) I say this went to be for me. (27) She waits here again. (28) That falls on through them. (29) Shoes are not on. (30) That goes to me. (31) You are seeing another paint in a minute. (32) I will go in a depot. (33) My wheels break. (34) I touch a last car. (35) I stand in the road. (36) John went off. (37) I do not look. (38) He did not turn on the knife. (39) That has done it without the song. (40) John comes. (41) This is making a seesaw. (42) That wants any garage. (43) You have these. (44) I will get done. (45) We look. (46) I am us. (47) We will be when I am feet. (48) Mine has not started to the girls. (49) I go to be the new swing. (50) The piece is going to give his shed the cap I get.

A probabilistic system offers a possible solution to part of the problem of designing a syntactic system of good positive fit, i.e. one that includes the many rather odd sequences which may on rare occasions be required, without letting their inclusion dominate the system. A study of the numbers occurring in the quantitative survey suggests that satisfactory results could be obtained by taking account only of the

interval in which the frequencies fall in a suitable logarithmic scale.

It will be observed that the system just illustrated introduces transition probabilities into what Chomsky (1957) calls a " phrase structure grammar." It is evident from the quantitative survey that the child begins by mastering phrase structure grammar before making much use of transformations of the kind discussed by Chomsky (1957) and Harris (1957).

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TABLE 1

@	:	Indef. art.
a	:	adjective uninflected (e.g. **good**)
a-er	:	adjective with comparative inflexion (e.g. **better**)
a-est	:	adjective with superlative inflexion (e.g. **best**)
a-ly	:	adjective + ly : (e.g. **properly**)
A	:	adjective phrase
C	:	command
d	:	adverb (subsets of d are listed in full : e.g. **Table 6**)
D	:	adverb phrase (consisting of selections from D1, D2, D3, D4, D5 as specified by Tables 8 and 9)
1	:	cardinal number greater than one
n-1	:	singular noun (e.g. **man**)
n-2	:	plural noun (e.g. **men**)
n (...)	:	right expansion of n head by items shown in brackets
ñ	:	proper name (e.g. **John**)
N	:	noun phrase
N_a	:	noun phrase occurring as right expansion of n (e.g. n(pN))
N_1	:	noun phrase occurring before finite verb phrase in subject position
N_2	:	noun phrase occurring after finite verb phrase
N_p	:	noun phrase occurring after preposition where pN = D2 or D3 or D4
p	:	preposition (fully listed in appropriate tables)
pr-1	:	**I, he, she, it, you, we, they**
pr-2	:	**me, him, her, it, you, us, them**
pr-3	:	**my, his, her, its, your, our, their**
pr-4	:	**mine, his, hers, its, yours, ours, theirs**
pr-self	:	**myself, himself, herself, itself, yourself, yourselves, ourselves, themselves**
r	:	**can, could, may, might, must, should, will, would**
Q	:	question
S	:	statement
V	:	statement type finite verb phrase (fully listed in **Table 4**)
VQ	:	interrogative finite verb phrase (fully listed in **Table 4**)
VC	:	command type finite verb phrase (fully listed in **Table 4**)
v-1	:	verb base uninflected (e.g. **tear**)
v-2	:	verb base + s (e.g. **tears**)
v-3	:	verb base + ing (e.g. **tearing**)
v-4	:	verb base + preterit inflexion (e.g. **tore**)
v-5	:	verb base + past participle inflexion (e.g. **torn**)
z	:	clause occurring as right expansion of n in n(z)

Syntactic symbols used in the quantitative survey

TABLE 2(a)

	.	D	D*	N	N*	ND	N'D	ND*	NN	NN*	NND	A	AD	NA	NAD	to v-1	v-3	N v-1	N to v-1	N v-1	N v-3	Other
be	171	404	234	1063	239	48	6	4				407	21		1							853
blow	1	16		30		14																0
break	21	6		22		9																0
bring				7	1	24	1															2
care	39	2																				2
catch		1		23		4																0
climb	2	19	2	1																		0
come	41	499				17						3										185
cut	2	2	3	15	1	17																1
dig	16	13		14		19	26															5
do	167	13	10	317	164	152	4	32	1						1							21
drink	2	6	3	15		7		4														0
eat	3	5		73		16																0
fall	8	57						1														1
find	1	1		29		5	2	1														0
finish	27	7	2	8		2		1														0
fix	4			17		15																0
get	4	817	1	822	45	335	14	32	16		1	24	6	11	1	98	7				5	40
give	1			5		43	2		211	4	30	2	3				7					1
go	118	704	66									2	3			698						120
hang		26		497	3			9									7	2	2			0
have	44	1		18		1	3									148						28
hear	3			26		122	1															1
help	5	1		26		4													4			0
hit	1	1		25		2		1										8				0
hold		4		18		14																0
hop	2	59																				0
hurry		50																				1
hurt	4			17		12																0
jump	10	50		9	2	2																0
keep			3	70		10		1				4					8					3
know	86	1	1	21	2	4		1							1					6		151
leave	2	1		5	2	32									1					175	1	26
let				65	2	13		1							1						1	3
like			3													7	8				6	0
live		19	7			6										7	6				6	0
look	13	154	2									6										587

V : Principal verb constructions.

TABLE 2(b)

	.	D	D*	N	N*	ND	N*D	ND*	NN	NN*	NND	A	AD	NA	NAD	to v-1	v-3	N v-3	N v-1	N to v-1	N v-3	Other
make	4	1		198	38	51		18	8					18				35				5
mind	1	7		24		7																1
move	4	12		4		12																0
paint	7	8		12		2																0
play	55	85	4	29	3	4	2							1								0
pull	2	5		7		35																0
push	4	4		28		39																2
put				7		394	7	7														0
read	2	1	1	43	1	5	7															0
run	5	31	2			1																0
say	4		2	30		36	2														12	90
see	26	8		181	1		1		19									27				37
show				13		3						2										14
shut		56		3		3					2											0
sit	1	142	4			2																0
stand	7	47	1	6		3								5			7					0
start		14	2			8											1					0
stay		32																				0
stop	27	14	3	74		4											15					0
take	1	1	1	75	1	157	1	1														1
tell	5	20		39	2	12			5											3		12
think				1																		46
throw		1		6		32	1															1
tip		12		3		47																0
touch	1			42		4																0
turn		14		2		30																1
wait	3	84														2						0
walk	5	32																	11	3		0
want	1			418	13	52		3								273						6
wash	2	9		19		5																2
watch	17	1		49		1												16				2
win	5			18		1	3															0
work	6	2	3	30		3	18							3		20						1
all other verbs	175	208	13	415	4	279	1	18	8	4		2		3		20			1			60

V : Principal verb constructions.

TABLE 3(a)

be

this ⎫
    ⎬ is
that ⎭

what* N V N*	— 14
what* N V pN*	— 3
when* N V D*	— 2
where* N V D*	— 6
why* N V D*	— 1
how* N V D*	— 19

there is

N⁺	—153
N⁺D	— 98
N⁺ v-3	— 6
N⁺ v-5	— 11
N⁺ v-5 D	— 1
not	— 1

(⁺ means not pr-1)

there pr-1

am/is/are	— 47
is D	— 4
are v-3	— 2

here is

N⁺	—116
N⁺D	— 14
N⁺ v-3	— 3
how* N V D*	— 1
where* N V D*	— 1

here pr-1 am/is/are	— 92
so am/is/was N	— 22
pr-1 am/is/so	— 3
A*	— 17
A*D	— 3
AD*	— 1
v-5 (see Appendix 1)	—213

bring

home N	— 1
in N	— 1

care

what* N V N*	— 1
if S	— 1

come

and v-1	—110
v-5	— 7
home v-5	— 1
here pr-1 come(s)	— 25
here comes N⁺	— 34
here comes N⁺D	— 5
out comes N⁺	— 3

cut

out N	— 1

dig

up N	— 2
up N*	— 2
up N D	— 1

do

so do/did I	— 7
I/you do/did so	— 9
what* N V N*	— 4
up N	— 1

find

S	— 1

get

out N D	— 1
pr-self N	— 2
N pr-self	— 1
N v-5	— 20
v-5	— 14
A D*	— 1
N A*	— 1

give

N N D*	— 1

go

away ⎫
off   ⎬ pr-1 { go / goes } — 24
here ⎪
there ⎭

v-1	— 1
v-5	— 2
and v-1	— 69

here goes { N⁺ — 11 / N⁺D — 1 }

there goes { N⁺ — 9 / N⁺D — 2 }

out goes N⁺	— 1

Verb constructions other than those shown in Table 2.

Table 3(b)

have
what* N V N*	— 1
N v-5	— 6
so have/has N	— 20
so	— 1

hear
of N D	— 1

help
v-1	— 1

hurt
pr-self D	— 1

keep
on v-3	— 3

know
S, you know	— 3
which one	— 1
which one to v-1	— 1
how many	— 1
why	— 4
what* N V N*	— 53
where* N V D*	— 23
which V	— 5
which n-1* N V N*	— 2
who V	— 5
who* N V N*	— 2
why* N V D*	— 3
how to v-1	— 11
where to v-1	— 2
what to v-1	— 1
how* N V D*	— 8
to v-1	— 1
S	— 25

leave
N alone	— 25
go	— 1

let
go	— 3

look
at N	—407
at what* N V N*	— 4
at N D	— 11
at N v-3	— 14
what* N V N*	— 78
what V	— 4
where* N V D*	— 20
who V	— 2
how* N V D*	— 8

how {big, deep, far, fast, high, low, many, much, wide} N V {D*, A*, N*} — 39

make
what* N V N*	— 1
up N	— 3
pr-self N	— 1

mind
S	— 1

put
on N	— 1
on N D	— 1

say
what* N V N*	— 1
C	— 4
Q } N said	— 2
S	— 3
S	— 80

see
what* N V N*	— 13
where* N V D*	— 3
who* N V N*	— 3
how* N V D*	— 3

how {deep, far, full, much} NV {A*, D*, N*} — 5
if S	— 9
S	— 1

show
N where to v-1	— 2
N what* N V N*	— 1
N where* N V D*	— 3
N how* N V D*	— 3
N how to v-1	— 5

take
off N	— 1

tell
N what* N V N*	— 3
N when* N V D*	— 2
N when to v-1	— 3
N if S	— 1
N that S	— 1
N what	— 1
N when	— 1

think
S, I think	— 2
what, where, who } do you think	— 14
S	— 30

throw
down N D	— 1

turn
out A	— 1

want
N v-5	— 6

wash
pr-self	— 1
pr-self D	— 1

watch
out what* N V N*	— 1
how* N V D*	— 1

work
pr-self	— 1

Verb constructions other than those shown in Table 2.

TABLE 4. Part 1a

	v-1/-2	d v-1/-2	v-1/-2 not	v-4	d v-4	v-4 not	am/is/are v-3	am/is/are d v-3	better v-1	better d v-1	r v-1	r d v-1	do/does v-1	do/does d v-1	did v-1	did d v-1	has/have v-5	has/have d v-5	was/were v-3	was/were d v-3	had better v-1	had better d v-1	has/have been v-3	r be v-3	r have v-5	r d have v-5
be	2131		253	87		10	13				74	18					14	1							1	
blow	2			10	3						7	1					3		1							
break	3	1		13	3		2	1			13	5											1			1
bring				13			4				1		43													
care	1			2	2																			2		
catch			25	4		25	51	12	1		4	6		2		3	5		1			1				
climb	103	2		15			51				27	10					8	1								
come	6						5	1			9	2					1		1							
cut	1			3			3	1	1		5	1		3	1	4	32	7	1							
dig	87	3		158	4		49	5			46	22		1		3	3	1	1							
drink	3			6			3	3			7	1		2			1	1								
eat	16			11	1		8	1		1	12	2					23	1	1							
fall	2			21	5		7	2				4					1	8					1			
find	1			17	2							7				1	1									
finish				4											7											
fix	55	2	25	4	1		1	20	3		10	3	3													
get		5	206	206	22		79		1		102	51	3		1	7	550	79	3		5					
give	4		20	20	1		3				35	28		11			16	2	1		1					
go	134	4	33	33	1		794	71	1		31	16	19			8	30	22			3					
hang				6			6	6				11					1	1								
have	140	3	18	61	5		22	13		1	96	16							5							
hear	1						6		1		11	11							1		3		1			
help	1	1		8	2						7	2								1	3					
hit	2						2	1			4	3									3					
hold				1				2			1	2							1	1						
hop	1						2				1	1														
hurry											4	1						1								
hurt	4			12				1			14	3							1		2					
jump	2			8							4															
keep	6						2				2	4	1				1									
know	158			4							2	4	89		8											

V: Finite verb phrase (statements).

V: Finite verb phrase (statements).

	v-1/-2	d v-1/-2	v-1/-2 not	9-v-4	d v-4	v-4 not	—am/is/are v-3	am/is/are d v-3	better v-1	better d v-1	r v-1	—r d v-1	do/does v-1	do/does d v-1	did v-1	did d v-1	has/have v-5	has/have d v-5	was/were v-3	was/were d v-3	had better v-1	had better d v-1	has/have been v	r be v-3	r have v-5	r d have v-5
leave																										
let	32										3	9		24												
like	14	1		1	1		6	2			10			2			10	1	1		1					
live	10			1	1		80	6			3		1	1				1	1		1		1			
look	14			43							42	4		2												
make							7				8	1		1		1	1	2				1	1	1		
mind	3			1			4	1			2	3		2			8	1								
move	2			2			18	30		1	4	5		1			6	1	1		1					
paint	2			3			6	1			15	3						1								
play	12	6		5	1		5	1			8	5				1	6		3							
pull	6			6			12	4			17	3		2				1								
push	13			46	1		2	1			34	2		1		1			1							
put	13			3			5				5															
read	2										3	1				1	6	1								
run				46			18	5		1	41	7		1			6	1	1		1		3	1	2	
say	5			37	6		7	1			22			1					3		2					
see	13			1			1	2			1	1		1			2		1		1					
show	2			3			5	1			10	1		3		1	2									
shut	6						7	1			4	1					1		1							
sit	10						5	2			7	1						2								
stand	3			3	4		3	2			2	4						1								
start	20			46	1		12	3			2	6					1		1							
stay				11			8	1		1	26	6					2		1							
stop	1			10			4				31	3		1												
take	5			4	2		1	1			9			1		1			1							
tell	1			5			3	2			11	1					2									
think	5	6		7			4				1	1				7	1		1		2	1			7	
throw				5			1				8			1												
tip	1			4	2		6				3	1						1								
touch	1			4			2	1			11	2		95					1		1					
turn	6			6			1	2		1	11						21	3	1						1	1
wait	1			2	8		2	2			8	1														
walk	5	1		1			2																			
want	442	6		4	2		6		1		3	1		1		2										
wash							1	1			11	2														
watch		1		6			6	2			2	1														
win	2			2			2	1																		
work	3			1	8		2	2			168	36	1	14		1	21	3	1					1	1	1
all other verbs	159	5		148	8		126	14	2	2	168	36	1	14		1	21	3	1	1					1	1

V: Finite verb phrase (statements).

TABLE 4. Part 2a

	VQ															VC
	v-1/-2 N₁	v-1/-2 not N₁	v-4 N₁	v-4 not N₁	am/is/are N₁ v-3	am/is/are not N₁ v-3	r N₁ v-1	r not N₁ v-1	do/does N₁ v-1	do/does not N₁ v-1	did N₁ v-1	did not N₁ v-1	has/have N₁ v-5	has/have not N₁ v-5	was/were N₁ v-3	v-1
be	530	29	7	2			2	1					4			19
blow							5									5
break																7
bring							1									9
care																
catch							1				1					7
climb											1					3
come					10	1	3		1		4					443
cut																10
dig					1	1			2		1					21
do	12	32	9	3	28		48	1	6	2	14		2			94
drink							1							1		12
eat					1		1		4							22
fall					1							4				3
find							1									3
finish														9		1
fix																5
get							35	1	10	3	28	1	62	4		459
give							7		1	1						205
go					80	12	18	4	15	1	4		7		1	212
hang																9
have	6	1			7		140	7	8	4	6		7			69
hear									1		3		1			1
help							3									10
hit										1						8
hold							3									14
hop																45
hurry																46
hurt											1					
jump							2				3	1				12
keep							1									16
know									54	4	1					69
leave							6									69
let							4					1				171
like							1		16	7	1					
live					2				2							
look					3				1	4						730

V : Finite verb phrase (questions and commands).

TABLE 4. Part 2b

	v-1/-2 N₁	v-1/-2 not N₁	v-4 N₁	v-4 not N₁	am/is/are N₁ v-3	am/is/are not N₁ v-3	r N₁ v-1	r not N₁ v-1	do/does N₁ v-1	do/does not N₁ v-1	did N₁ v-1	did not N₁ v-1	has/have N₁ v-5	has/have not N₁ v-5	was/were N₁ v-3	v-1
						VQ									VC	
make					16		8		3	3	3	2	1			52
mind					1		1		1							24
move																15
paint																5
play					3	3	20		1							13
pull					2					1						13
push					1							1				35
put					2		16		1	4	4					194
read							4							2		17
run					1		1									3
say							4			1	13					63
see							8	2	1		11	1	3			72
show																24
shut																60
sit							3		1							59
stand							1									20
start																6
stay							1				1					10
stop							3									89
take					2		12		1	2	1					73
tell							3									19
think									16		1					15
throw											1					15
tip							2				1					27
touch					1											23
turn							1									16
wait							1								1	76
walk																6
want									204	12	2					
wash							1									2
watch							1									78
win																
work							1		3	1						23
all other verbs						14	27		14	4	8					239

V : Finite verb phrase (questions and commands).

TABLE 5

	r (d) v-1	r be v-3	r (not) have v-5	r (not) N v-1	N r (not)	r (not) N
can	0·3008			0·6948	0·3654	0·3157
could	0·0268			0·0446	0·0288	0·0527
may	0·0009			0·0071		
might	0·0134	0·1300				
must	0·0134		0·1300			
should	0·0178	0·3300	0·7400	0·0071	0·0193	0·0527
will	0·6053	0·5400		0·2253	0·5000	0·5789
would	0·0216		0·1300	0·0211	0·0865	

Probabilities of values of r in V and VQ.

TABLE 6

	d v-1/-2	v-1/-2 not	d v-4	v-4 not	am is are } d v-3	better d v-1	r d v-1	do does } d v-1	did d v-1	has have } d v-5	was were } d v-3	had better d v-1	r d have v-5
not		1·0000		1·0000	0·7514	1·0000	0·9216	0·9908	0·9815	0·6671		1·0000	1·00
already			0·0142							0·0072			
all					0·0230		0·0034			0·0217			
nearly all					0·0138								
always	0·0810				0·0046								
both							0·0068						
easily			0·0142				0·0034						
even	0·0270						0·0034			0·0072			
not even					0·0046		0·0239	0·0092					
hardly							0·0034						
just	0·2972		0·2714		0·0645		0·0102			0·0362			
not just									0·0185				
nearly	0·0270		0·3005		0·0276					0·0434			
never	0·0540		0·2285							0·0072			
only	0·4328		0·1142		0·0829		0·0137			0·1594			
really			0·0142										
not really										0·0072			
still	0·0540		0·0428		0·0276		0·0102			0·0434			
usually	0·0270												

Probabilities of values of d in V.

TABLE 7

Prefix	Probability
zero	0·8391
all	0·0004
all you	0·0004
both	0·0002
do not you	0·0034
do not	0·0632
just	0·0071
now	0·0100
everyone	0·0002
one of you	0·0002
some of you	0·0004
somebody	0·0012
someone	0·0014
nobody	0·0004
you two	0·0002
you	0·0718
now you	0·0002
now just	0·0002

Probabilities of various prefixes to v-1 in commands.

TABLE 8

D1	D2	D3	D4	D5	
0	0	0	0	0	0·0166
0	0	0	0	1	0·0185
0	0	0	1	0	0·0810
0	0	0	1	1	0·0003
0	0	1	0	0	0·0433
0	0	1	1	0	0·0019
0	0	1	1	1	0·0002
0	1	0	0	0	0·3026
0	1	0	0	1	0·0034
0	1	0	1	0	0·0141
0	1	1	0	0	0·0010
1	0	0	0	0	0·4194
1	0	0	0	1	0·0045
1	0	0	1	0	0·0289
1	0	0	1	1	0·0002
1	0	1	0	0	0·0125
1	0	1	1	0	0·0010
1	1	0	0	0	0·0489
1	1	0	0	1	0·0002
1	1	0	1	0	0·0015

Probabilities of possible combinations of D1-5 as values of D.

TABLE 9(a)

D1			
ACROSS	4	nearly up	1
ALONG	4	right up	12
AROUND	20	way up	2
all around	2	UPSIDE DOWN	3
right around	1		
AWAY	67	**D2**	
right away	1	ABOUT N	4
BACK	94	ACROSS N	8
straight back	1	ALONG N	6
backwards	1	AROUND N	8
BEHIND	1	AT N	63
DOWN	218	right at N	1
nearly down	2	nearly right at N	1
right down	11	BEHIND N	11
nearly right down	1	BY N	9
downwards	2	DOWN N	84
EVERYWHERE	6	right down N	2
HERE	134	nearly right down N	1
right here	1	EXCEPT N	1
HOME	71	FOR N	116
IN	219	FROM N	7
just in	1	IN N	484
right in	4	right in N	4
INSIDE	15	INSIDE N	2
NEAR	1	NEAR N	9
NEXT	20	right near N	2
OFF	266	OUT OF N	57
all off	1	OFF N	68
ON	657	ON N	425
OUT	450	nearly on N	1
nearly out	2	right on N	3
only out	1	OUT N	37
right out	3	right out N	1
OUTSIDE	19	OVER N	120
right outside	1	all over N	16
OVER	96	further over N	1
right over	3	right over N	6
PAST	5	PAST N	7
ROUND	17	ROUND N	16
all round	3	all round	1
SOMEWHERE	3	THROUGH N	9
somewhere else	1	right through N	2
THERE	134	TO N	334
just there	1	UNDER N	22
nearly there	1	UNDERNEATH N	1
right there	2	UP N	149
THROUGH	9	right up N	8
right through	1	straight up N	1
TOGETHER	5	WITH N	138
UNDER	5	WITHOUT N	4
UNDERNEATH	4	WHERE N V	25
UP	571	WHEREVER N V	1
all up	2	EVERYWHERE N V	2

D1 and D2 : adverbial phrases.

TABLE 9(b)

D3

alright	12	loud	2
at all	2	lovely	1
too big	1	mad	1
a bit	5	any more	4
a big bit	1	a bit more	1
a little bit	1	much	1
by pr-self	11	very much	1
all by pr-self	3	as much as N	1
more deeply	1	nicely	1
any deeper than N	1	on pr-3 own	1
that end	1	properly	6
far	1	quick	8
too far	2	very quick	1
very far	1	quickly	1
that far	1	quicker than N	1
far enough	1	really	3
as far as N	1	right	2
any further	2	that side	1
fast	51	the other side	2
too fast	8	slow	10
very fast	2	a bit slow	2
terribly fast	1	slowly	2
this fast	1	straight	1
a bit fast	1	tight	4
fast as N	2	that way	11
faster	5	another way	5
faster than N	7	this way	17
that fast it smashed	1	the other way	1
fine	1	the wrong way	5
first	40	all this way	1
good	2	a long way	2
better	1	a long long way	1
better than N	1	all the way up	1
very well	1	the way you get off	1
hard	6	wrong	1
hard enough	1	twice	1
high	13	the best	1
really high	1	1 miles	1
too high	1	1 miles an hour	2
as high as N	1	only that	1
as high as you can	1	on fire	4
higher	1	next door	1
a bit higher	1	like N	81
higher than N	1	like N V	6
instead	1	as N V	2
1 times	2		

D3 : adverbial phrases.

TABLE 9(c)

D4

after	21	longer than N	4
afterwards	5	a minute	16
after N	43	five minutes	1
just after N	1	a moment	1
after N V	2	every morning	1
this afternoon	1	this morning	1
again	105	tomorrow morning	1
already	6	all night	6
at dinner time	1	every night	1
at night time	1	last night	5
at Christmas	1	tonight	8
at last	1	now	213
at once	3	right now	1
at seven	1	on Saturday	2
at ten	1	once	2
before	11	once more	1
before N	7	Saturday	1
before N V	5	soon	4
by then	1	sometimes	2
next Christmas	2	still	2
all day	3	till late	1
another day	1	till teatime	2
every day	5	till N V	21
one day	3	this time	9
the other day	3	that time	2
twelve days	1	a long time	2
early	1	all the time	19
earlier than N	1	all the time when	
for ages	1	I am doing this	1
for Christmas	4	next time	1
for the day	1	same time as N	1
for one day	1	the other time	1
for about two days	1	then	15
for a while	3	today	18
for hours	1	tomorrow	8
for long	1	when N V	21
for a minute	7	whenever N V	1
in a quarter half	1	while N V	3
in a few minutes	1	next year	1
in a minute	29	yesterday	8
in about two minutes	1	yet	43
in the morning	4		
in time	1		
in two minutes	1	**D 5**	
in two more minutes	2	anyhow	2
last	3	anyway	5
later	1	either	10
very long	1	though	7
any longer	1	too	143

D4 and D5 : adverbial phrases.

TABLE 10

a	346
a-er	11
a-est	3
all a	10
awfully a	1
just a	2
no good	1
pretty a	1
quite a	1
really a	1
so a	2
sopping wet	1
still a	1
that a	2
this a	1
too a	19
very a	8
@ bit a	1
a enough	3
a as N	4
as a as N	4
a-er than N	9
even a-er than N	1
still a-er than N	1
scared of v-3	2
able/easy/game/hard/scared to v-1	20
too a to v-1	2
afraid/full/scared/sick of N	5
big/deep/good/late/ready/right/safe for N	9
full/good to N	2
a and a	12

A : adjective phrase.

TABLE 11. Part 1(a)

	N_a	N_1	N_2	N_p
@ n-1	24	133	980	56
@ n-1 (p N)		10	109	
@ n-1 (to v-1)			6	
@ n-1 (v-5)			1	
@ n-1 (z)		1	5	
@ a n-1	3	17	211	6
@ a n-1 (p N)		1	14	
@ a n-1 (to v-1)			5	
@ a n-1 (v-3)			1	
@ a a n-1		4	12	2
@ pretty/very a n-1			4	
@ a-er n-1			8	
@ a-er n-1 than N		1	5	
all @ n-1			1	
only @ a n-1		2		
such @ n-1			1	
all n-1		1	2	
all n-2			3	
all a n-2		1	2	
another n-1		35	80	6
another n-1 (p N)			14	
another n-1 (here)				1
another n-1 (to v-1)			1	
another n-1 (z)		1		
another a n-1			3	
another a n-1 (pN)			1	
any n-1			31	1
any more n-1			6	
any a n-1			1	
any n-2			18	
any more n-2		2	1	
any n-2 (p N)		1		
enough n-1			2	
much n-1		1	1	
n-1	114	64	190	133
n-1 (p N)			10	4
n-1 (to v-1)			6	
a n-1		2	13	1
a n-1 (p N)			2	
a n-1 (z)		1		
a a n-1			1	
next n-1				1
number 1		1	11	
very a n-1			1	

	N_a	N_1	N_2	N_p
n-2	45	37	193	18
n-2 (p N)		3	3	
n-2 (v-3)			1	
n-2 (z)			1	
a n-2	3	1	31	1
a a n-2			2	
a-er n-2			1	
very a n-2			2	
other n-2		1		
ñ-1 (male)	38	148	74	27
ñ-1 (female)	7	54	39	11
ñ-1 (other)			4	15
one n-1		6	17	3
one n-1 (p N)			2	
only one n-1		1		
only a n-1			1	
one more n-1		1	3	
one more n-1 (p N)			2	
1 n-2	3	7	59	1
1 n-2 (p N)			8	
1 n-2 (to v-1)			1	
about 1 n-2			2	
only 1 n-2		1		
1 a n-2	3	5	5	
1 more n-2		1		
pr-3 1 n-2			3	1
much n-1		1	1	
so much n-1			1	
many n-2			1	
too many n-2		1		
that many n-2			1	
more n-1		1	3	1
more n-1 (still)			1	
more n-1 (than N)			1	
a bit more n-1			1	
more n-2			1	
more n-2 (to v-1)			1	
more a n-2			1	
no n-1		10	6	
no n-1 (p N)			2	
no more n-1		2	1	
no n-2		2	10	
no more n-2		4	1	
only n-1		2		

N : noun phrases (n - head).

TABLE 11. Part 1(b)

	N_n	N_1	N_2	N_ν
pr-3 n-1	26	272	560	212
pr-3 n-1 (p N)		1	8	1
pr-3 n-1 (to v-1)			2	
pr-3 a n-1	1	2	31	2
pr-3 a a n-1		1	1	
pr-3 other n-1		5	6	
pr-3 own n-1			6	3
all pr-3 n-1		4	4	
pr-3 n-2	7	49	200	22
pr-3 a n-2			11	1
pr-3 a a n-2			1	
pr-3 own n-2			2	
all pr-3 n-2		1	13	
all pr-3 n-2 (z)		1		
all pr-3 a n-2		1		
some n-1	1	11	98	1
some n-1 (p N)			4	
some n-1 (to v-1)		1		
some a n-1			5	
some more n-1		3	57	
some n-2		10	40	
some n-2 (p N)		1	1	
some more n-2		1	9	
some more n-2 (than N)			1	
that n-1	11	59	187	54
that n-1 (there)		6	6	1
that n-1 (p N)	2	1	10	
that n-1 (z)		2		
that a n-1		7	11	
that a n-1 (there)				1
that a n-1 (z)			1	
that a a n-1				2
that other n-1		2	3	1
that other n-1 (there)			1	
all that n-1			2	
all that a n-1		1		
those n-2	4	16	15	4
those n-2 (p N)		1	2	
those n-2 (z)		2		
those a n-2				1
those 1 n-2			1	
all those n-2	1		3	
this n-1	8	46	142	51
this n-1 (p N)		1	3	
this n-1 (here)			1	
this other n-1			1	1
this a n-1		3	6	1
this a a n-1			1	
all this n-1			4	

	N_n	N_1	N_2	N_ν
these n-2	3	3	10	
these n-2 (p N)				1
these a n-2			1	
all these n-2			2	
these 1 n-2			1	
the n-1	56	182	514	468
the n-1 (there/home/out)			3	2
the n-1 (p N)	1	1	16	15
the n-1 (to v-1)		1	3	
the n-1 (v-3)		1	1	1
the n-1 (z)		1	21	1
the a n-1	4	22	61	13
the a n-1 (there)			1	
the a n-1 (p N)	1		5	1
the a n-1 (z)			1	
the a-est n-1	2		9	1
the a-est n-1 (p N)			2	
the next n-1		2	1	
the first/second n-1			6	
the other n-1	2	8	12	17
the other n-1 (p N)		2	2	1
the same n-1			3	1
the same n-1 as N			4	2
the a a n-1	1	4	4	
the a a n-1 (p N)			1	
the other a n-1		1		
all the n-1	1	11	29	2
all the n-1 (p N)			1	
all the n-1 (z)			1	
all the a n-1			1	
the n-2	8	40	78	34
the n-2 (p N)			2	
the n-2 (z)			1	
the a n-2	2	2	6	
the other n-2	1	2		
the same n-2			5	
all the n-2		12	16	
all the a n-2		2		
all the other n-2		1		
both the n-2			1	
only the n-2		1		
the 1 n-2		1	2	
the 1 a n-2			1	

N : noun phrases (n - head).

TABLE 11. Part 2(a)

	N_a	N_1	N_2	N_p		N_a	N_1	N_2	N_p
all			22		much			2	
all (of N)			13		not much		1		
all (z)			13		this much		1		
this all			2		too much		1	3	
another		2	5		none		3	7	
					none (p N)		1		
any		1	16		nearly none		1		
any (p N)			3						
any (to v-1)			1		plenty (p N)		1	2	
enough			21		some		10	101	1
enough (p N)			1		some (of N)			20	
enough (to v-1)			1						
					that	37	552	303	71
one	7	26	149	2	that (outside)			2	
one (p N)	1	5	34	2	that (p N)		1		
one (z)		2			that (z)		1		
one more			2		all that			4	
one more (p N)			1		all that (p N)			1	
one more (to v-1)			1						
only one more (to v-1)		1			this	18	228	185	68
1 (cardinal))	3	11	85	7	this (here)		1		
about 1			2		this (p N)		1	1	
1 (p N)			10		all this		2	7	
1 the same as N		1							
1 more		1	1		these	19	20	23	3
the 1			2		all these			4	
these 1		3	2						
those 1			1		those	4	1	5	
					all those			2	
that many		1							
					the other				1
more			7		the others		1		
more than N			11		some others (to v-1)			1	
any more			23		all the others		1		
any more (p N)			1		any others			1	
no more		5	1						
some more		2	42	1					
some more (p N)		1							
@ lot more			1	1					
@ little more			1						
@ few more		1							

N : noun phrases (non n - head).

TABLE 11. Part 2(b)

	N_n	N_1	N_2	N_p
he		450		
I		4614		
it		776		
she		252		
they		270		
we		608		
you		1856		
they/we all		3		
we both		1		
her			57	23
him	2		97	34
it	16		1142	131
me	9		521	145
them	24		152	14
us	2		173	21
you	16		299	157
them over there			1	
them there	1			
it all		22		
them all			10	
all them			4	
hers		1	4	2
his			5	
mine	6	148	218	19
ours		2	4	2
yours	7	21	38	14
all hers			2	
all his			1	
all mine			7	
all yours			2	
pr-self	1			3
pr-3 own	1		6	4

	N_n	N_1	N_2	N_p
anybody		4	7	
anyone		2	8	1
anything		1	14	2
everybody		2		
everyone		1		
everyone (d)			1	
everything		2	6	1
nobody		8	2	
nobody else		1		
no-one		8		
no-one to v-1			1	
no-one else		2		
nothing		1	3	
nothing (p N)		1		
nothing (to v-1)			1	
somebody		11	2	
somebody to v-1			1	
somebody else			1	2
someone		34	5	
someone to v-1			1	
someone (d)		1		
someone else			5	1
something		4	30	2
something (a)			3	
something (p N)			2	
something (z)			2	
something else		1	4	1
something else (z)			1	
the a-est			18	
the a-est (p N)			1	
here	3	-		176
there	16			293
N and N	2	13	29	4
N or N			1	2
N's	22	3	12	8
N's N		8	44	15
Remainder	7	6	45	3*

N : noun phrases (non n - head).

TABLE 12

	n-1	n-2		n-1	n-2		n-1	n-2		n-1	n-2
apple	31	1	drink	23	1	locker	10	0	scissors	0	10
arm	6	5	driver	7	2	look	26	0	seat	14	1
baby	64	7	end	22	1	lot	47	4	seesaw	33	1
back	30	0	engine	10	1	man	65	9	shed	12	1
ball	10	0	eye	4	7	middle	9	0	sheet	7	1
bath	8	3	face	27	1	milk	37	0	ship	15	1
beach	12	0	father	18	3	mother	23	3	shoe	15	89
bear	19	10	finger	3	4	mouth	18	0	shore	17	0
bed	114	1	fish	10	0	music	7	0	shovel	61	6
bike	125	12	flower	5	3	nail	6	5	side	29	3
bit	60	4	fly	8	4	name	90	2	sister	9	0
blanket	2	6	foot	17	37	noise	10	0	sleep	14	0
block	8	12	fork	8	1	nose	13	0	slide	7	4
board	19	0	front	12	0	number	47	10	snake	8	2
boat	102	50	game	9	1	one	463	22	soap	8	0
book	97	10	gaol	9	2	orange	33	1	sock	3	11
bottom	11	0	garage	48	0	paint	17	2	song	7	3
box	10	0	garden	12	4	painting	6	0	spade	8	0
boy	63	16	gate	14	2	pants	0	21	spider	10	0
bread	9	0	girl	60	21	paper	20	0	station	11	0
bridge	12	0	glass	18	4	part	10	2	steamer	6	1
brush	11	3	go	23	0	party	13	0	step	5	3
bubble	15	56	grass	14	0	people	0	7	story	13	2
bucket	27	4	green	7	0	petrol	8	0	sugar	17	0
bump	2	18	ground	16	0	photo	9	1	swing	101	8
bus	68	12	gun	6	3	picture	14	21	table	47	3
butter	32	0	hair	14	0	pie	6	9	tea	34	1
button	5	4	hammer	15	1	piece	31	10	teacher	37	4
cake	17	4	hand	20	34	pig	5	3	thing	25	29
cap	6	2	hanky	10	0	pin	9	4	time	29	1
car	98	12	hat	35	5	pipe	14	9	tin	8	2
carrot	16	2	head	34	3	place	20	0	tooth	4	11
caterpillar	8	7	hole	67	5	plane	24	2	top	44	0
chair	24	5	horse	36	9	plate	13	0	train	14	2
cheese	11	0	hose	14	0	pram	22	2	tree	57	1
chimney	8	0	house	51	6	pudding	9	1	trousers	0	7
clay	8	0	idea	8	0	purse	7	0	truck	20	0
colour	10	3	jug	6	3	push	9	0	tunnel	7	0
corner	8	0	jumper	8	0	race	13	0	turn	29	6
cow	7	1	kettle	7	0	record	5	2	tyre	11	7
cup	28	2	kid	12	16	red	10	1	vegemite	9	0
cupboard	14	0	kindergarten	14	0	rest	15	0	water	253	0
depot	10	3	knife	35	2	ride	22	1	way	61	0
dinner	31	0	ladder	13	1	river	15	1	wheel	12	9
dirt	17	0	lady	15	3	road	32	5	whistle	7	0
dog	20	2	leader	13	1	roof	10	0	window	17	4
doll	44	7	leg	18	14	room	10	0	wolf	8	0
door	20	3	light	3	12	sand	40	0	wood	12	0
dough	9	0	lizard	7	1	sausage	7	5	yellow	13	0
dress	39	8	loan	12	0	school	22	1			

Frequently occurring values of n in N.

TABLE 13(a)

	zero	@	one/l	all	another	any	more	much	no	pr-3	some	that/those	the	this/these
apple	9-1	7-0				5-0				11-0	2-0	1-0		
baby	1-0	13-0	0-4							26-3			14-0	5-0
back										5-0			25-0	
bed	33-1	7-0								46-0		6-0	19-0	3-0
bike	0-1	27-0	0-1		2-0	0-1			0-1	56-2		11-0	21-3	5-0
bit	1-1	38-0	2-3		7-0					3-0		2-0	5-0	2-0
boat	0-9	21-0	3-5		2-0		0-3			30-2	0-2	3-2	11-12	4-1
book	0-5	55-0	1-2		7-0				1-0	11-0		13-0	1-2	8-1
boy	0-10	18-0	1-0		3-0					8-0	0-1	24-3	6-0	
bubble	0-18	7-0				0-1	4-1			4-16	0-11		1-5	2-0
bucket	0-2	6-0	1-2		1-0					2-0		1-0	13-0	2-0
bus	0-1	11-0			3-0			-	-	14-1	-	1-0	26-7	4-1
butter	6-0						1-0			1-0	2-0		4-0	
cake	0-2	11-0								2-0	2-1		1-0	
car	0-4	26-0	2-1		2-0		0-1		0-1	18-0		2-1	20-3	8-0
chair	0-1	8-0	0-1							5-1		1-0	5-2	2-1
cup		16-0			1-0					9-0	1-2		1-0	
dinner	10-0	1-0				2-0	1-0		1-0	20-0	1-0		2-0	
dog	1-0	5-0	0-1							10-0		0-1	1-0	
doll	0-2	11-0					0-1			10-0		1-0	6-3	5-1
door	1-1	6-0							0-1				12-1	
dress	1-2	4-0	0-1							28-4		2-0	2-3	2-0
drink	1-0	22-0	0-1											
end	0-1	1-0	1-0							1-0		3-0	11-0	4-0
face	1-0	5-0							1-0	17-0			2-1	
foot	0-2	2-0	1-0							10-35			4-0	
garage		10-0								27-0			10-0	1-0
girl	0-7	13-0	0-1		5-0					10-0	0-1	1-2	6-7	2-0
glass	4-2	3-0	0-1					-	-	5-0	1-0	-	4-1	
go		18-0			2-0					3-0				
hand	0-4	2-0	0-2							18-27		1-0	1-0	
hat	0-2	5-0							1-0	17-0		1-0	1-0	1-1
head	0-1		0-1							33-1			1-0	
hole	1-1	21-0	0-1		6-0	0-1				23-2		5-0	8-0	1-0
horse	0-3	14-0	1-1		2-0					4-1	0-1	2-0	10-3	2-0
house	0-2	16-0		0-1	1-0					4-0		2-0	18-0	3-0

Distribution of some high frequency noun head words with some quantifiers.

Table 13(b)

	zero	@	one/1	all	another	any	more	much	no	pr-3	some	that/ those	the	this/ these
knife		18-0	1-2						1-0	11-0		1-0	2-0	
leg	0-2	1-0	4-0							11-11			1-2	
look		26-0												
lot	0-3	32-0	0-1										15-0	
man	0-4	15-0	0-1			0-1				1-0		1-0	12-0	
milk	11-0					5-0	4-0		1-0	9-0	1-0		6-0	
name			0-2							86-0			1-0	
number	1-1	8-0								15-2		4-0	10-0	0-1
one	0-6	65-0	0-6		60-0					22-2		123-0	42-4	114-3
orange	13-0	7-0	0-1			2-0	1-0			10-0				
picture	0-3	10-0		0-1	1-0		0-1			1-2	0-2	1-0	0-11	1-0
piece	4-2	13-0	3-7		7-0					1-0	0-1	2-0		
pipe		4-0								3-1	0-1	3-0	0-2	1-1
place		3-0	1-0							14-0			2-0	
pram	1-1	10-0								5-0		1-0	2-1	2-0
ride		21-0	1-1											
road	0-1	7-0	0-1							9-2		1-1	10-0	4-0
sand	19-0						1-0				2-0		18-0	
shoe	0-2	4-0	1-0			0-1		0-4		9-90		0-1		1-1
shovel	0-1	21-0				0-1				17-1	5-0		15-3	1-0
side	0-2									4-0		4-0	16-1	4-0
swing	0-4	56-0				0-1		0-1		12-2		11-0	17-0	3-0
table	0-1	6-0								1-1		3-0	35-1	
tea	21-0						2-0	1-0		9-0	0-1			
teacher	8-1	4-0				1-0		2-0		5-1			17-2	
thing	0-1	4-0	0-2	0-1						4-7		8-6	6-8	7-0
time	7-0	2-0	0-1							1-0			5-0	1-0
top	10-0												33-0	
tree	2-1	8-0			2-0							1-0	35-0	4-0
turn	0-6	16-0								13-0				
water	54-0		1-0			5-0	43-0	2-0	2-0	3-0	41-0	8-0	88-0	3-0
way		4-0			1-0					3-0		21-0	21-0	9-0
window		2-0								2-0			13-3	0-2

Distribution of some high frequency noun head words with some quantifiers.

TABLE 14

	a in N	a in A		a in N	a in A
alive		4	hot	2	9
bad	14		late		1
beautiful	8	6	last	5	1
big	131	20	little	140	1
bigger	4	12	long	11	6
biggest	9	1	lovely	8	3
black	10	9	lucky	1	5
blue	8	4	mad	23	2
clean	2	3	new	21	
dark		5	nice	10	10
dead	1	7	old	17	2
deep	6	7	pretty	11	4
deeper		1	prettiest	6	
different	7		proper	3	
dirty	5	9	quick		2
dry	4	6	quickest	1	
fast	1		real	12	2
faster	1		ready		13
full	1	4	red	7	15
fullest	1		right	2	21
funny	21	9	sick	5	2
good	41	18	silly	4	14
better	9	5	slow	1	3
best	5	1	soft		5
green	1	9	sore	6	2
hard	3	5	strongest	2	
harder	1		tired		5
heavy		4	wet	5	30
high	5	2	white	2	6
higher	1	2	whole	26	
highest	4		wrong	7	2
			yellow	5	5

Some values of a in N and A.

TABLE 15

about	0·0058
at	0·0379
by	0·0029
down	0·0058
for	0·0175
from	0·0058
in	0·0437
like	0·0379
of	0·6941
on	0·0408
out	0·0087
over	0·0437
to	0·0146
up	0·0029
with	0·0379

Values of p in Table 11 and their probabilities.

TABLE 16

her	0·0257
his	0·0486
its	0·0049
my	0·5660
our	0·0646
their	0·0111
your	0·2791

Values of pr-3 in Table 11 and their probabilities.

TABLE 17

Type	Example	Quantity
N VQ	Can you catch this ?	1160
what* N VQ N*	What have you got ?	292
what n* NQ V	What book have you read ?	16
what* N VQp N*	What is it for ?	11
which n* N VQ N*	Which plate do you want ?	5
who* N VQp N*	Who is that for ?	2
whose n* N VQ N*	Whose runners are these ?	3
whose* N VQ N*	Whose is that ?	7
where* N VQ D*	Where is the clock ?	240
how* N VQ D*	How can we dry these ?	58
how d* N VQ D*	How far did you go ?	15
when* N VQ D*	When did you do that ?	22
why* N VQ D*	Why did you throw that ?	48
Int. End.	We need the water don't we ?	285
NQ V	Who did this ?	192

Values of NQ

who	160
what	17
which	6
which n-1/2	4
what n-1	1
how many n-2	3
who else	1

Types of questions.

TABLE 18

	I	we	you	he	she	it	they	there
am	1							
are		4	4				4	
are not	4	6	9				9	
is				1	3	9		1
is not				4	5	61		1
was						1		
was not						1		
do		4	5					
do not	7	10	6				2	
does not				2	1	5		
did	1	1	2					
did not	6	8	8	2		3	1	
has				1				
has not				1		1		
have			1				1	
have not	3	7	3					
can	2	1			1			
can not	2	4	4			1	1	
could			1	1				
could not		1						
might not			1					
will	1	1	22		2	1		
will not		6	7	1	1		1	
would			1					
should not		1						
would not			1					

Interrogative endings.

TABLE 19

Non-Standard	For Standard		Non-Standard	For Standard	
aint	are not	3	hanged	hung	1
aint	have not	3	has	have	1
aint	is not	4	heared	heard	1
are	am	11	helded	held	1
are	is	4	is	are	6
blew	blow	1	lay	lie	6
blowed	blown	1	loosed	lose	1
blowed	blew	4	lost	lose	1
brang	brought	1	sanking	sinking	1
brought	bring	1	saw	seen	2
breaked	broke	1	seen	saw	6
broke	break	3	sweared	swore	1
broke	broken	13	took	taken	1
broked	broke	2	tooken	taken	2
broked	broken	3	was	were	11
catched	caught	2	went	gone	1
come	came	6			
come	comes	2	mans	men	1
comed	came	1	foots	feet	1
digged	dug	2			
did	done	1	her	she	3
do	does	10	mine	my	3
done	did	91	mine's	mine	1
drank	drunk	1	no	any	37
drinked	drank	2	none	any	7
drink	drank	3	she's	her	1
drived	drove	1	them	they	1
eat	eaten	1	them	those	9
falled	fell	6	they	those	9
flyed	flew	1	youse	you	22
give	gave	1			

Non-standard forms.

Appendix 1

allowed		3
„	to v1	28
„	in here	1
„	in it	1
„	in there	2
„	to if you want to	1
„	on this road	1
„	up that way	1
anchored		3
„	right out here	1
blown away		1
broken		23
„	again	3
„	off	1
buried		1
„	too	1
busted all up		1
called		3
caught		4
coloured before		1
covered up		1
crashed into the tunnel		2
cut off		1
„ „	soon	1
done		3
„	up there	1
„	up	1
„	up on the shoulder	2
dragged out		1
dried over		1
dug		1
„	enough	1
fallen over now		1
filled		1
„	up to the top	1
finished		29
„	by then	1
„	this	1
„	with her	1
„	yet	3
fixed		1
„	now	1
flooded		1
frightened		1
too frightened to v-1		1
given		1

gone		8
„	already	1
„	now	3
got		1
killed		1
„	at the war	1
„	now	1
„	yet	1
knocked down		1
left		2
„	behind	1
„	in there	1
„	now	1
lost on it		1
„	too	1
lined up		1
made		2
„	now	1
„	of paper	1
„	out of sticks	1
„	out of sand	1
painted		2
„	up here	1
puffed out		4
pulled down		1
„	in	1
„	into shore	2
pushed in the cupboard		1
put out		2
a bit scratched		1
spoilt		1
squashed up like that		1
stopped		1
stuck		1
„	together	1
sunk under there		1
supposed to be v-3		4
tied		1
tossed up		3
tricked		1
undone		5
unwound		1
used for submarines		1
washed		2
„	up properly	1

Details of be v-5 constructions

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